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W. G. KAISER, President — RAYMOND OLNEY, Secretary-Treasurer

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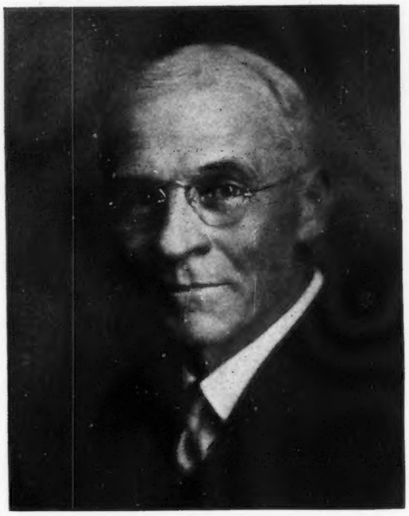
The Engineer and Civilization[1]

By William Boss[2]

THE American Society of Agricultural Engineers was organized but twenty-two years ago and thus far it has enjoyed a splendid development in an opportune era. To continue its growth and usefulness requires thoughtful and purposeful planning on the part of its membership. Observation indicates that the essential life processes of the individual plant, animal or man do not materially change through the ages but that regeneration seems frequently to be necessary for wholesome collective development. This is especially true of man-made organization of whatever character. In my opinion we as a society have reached a stage in our development where such regeneration is impending. In the past we have grown wholesomely by the very stimulus of multiplicity of things for us to do. The time for more selective activity is here, and we must choose with more care for the future than we have done in the past. We should therefore at this time establish a platform of the fundamental principles for which we stand and lay down a definite program of activity in support thereof such as will enable our Society to continue to render a service to humanity throughout all time.



William Boss

During the year just past an attempt has been made by the Council of the Society to outline a suggested platform and prepare a correlative program of activity for the guidance of our membership. The Secretary of the Society has compiled the more definite of the suggestions thus far offered, and these will be submitted to the membership for further suggestions and criticism before they are finally adopted by the Society.

The needs of any organization develop with its growth and the caring for these needs should be definitely provided for. One of our apparent needs is the development of our individual members to an appreciation of the important place and opportunity which they hold as members of the Society. The normal field of agricultural engineering embraces three principal lines of activity, namely, reclamation, structures, and machinery. In addition to being generally familiar with the entire agricultural engineering field, which is understood to include an effective background of agriculture and economics, the agricultural engineer should specialize in one of the three distinct lines mentioned, and give the greater part of his constructive effort to this definite field. A new member should immediately identify himself with one of these specialized groups and through his chosen line, grow into activities of the Society.

I wish to recommend that as soon as it seems consistent so to do the Society so reorganize its administrative system as to elect three vice-presidents, each to be a specialist in one of the three lines of specialization mentioned, to act as chairman of the division representing that field and to be jointly responsible with the president and secretary for the activities of his division. Each division should be further organized into its principal lines of activity with a committee membership for each member, thus making society activity possible for each member and urging upon him his responsibility to assume such activity. Nature seems to regard the individual and not the groups, except that good groups are composed of good individuals and we must provide for the growth of the individual if our Society is to continue to grow in usefulness. On this account I would also recommend that each member's chosen line of specialization be indicated in the membership directory of the Society. I believe that such a plan as the foregoing earnestly followed by us all promises to fit our members well for the calls to high duty that are coming to agricultural engineers with increasing frequency.

HONORS OF THE YEAR

Your president by virtue of his office is a member, for two years, of American Engineering Council which holds its annual meeting at Washington, D. C., in January of each year. On this Council he also becomes a member of the administrative board, and your present president is chairman of Council's committee on reforestation, and a member of the committee on program of research and the committee on amendment to the Federal Constitution. Council is entirely sympathetic towards agriculture and is anxious to render any possible assistance to our Society in carrying on its work. During the past year our Society has received an invitation to take part in the World Engineering Congress at Tokio, Japan, in October of this year, and we are fortunate in being able to have Prof. H. B. Walker represent the Society at that meeting. Mr. S. H. McCrory represented the Society at a meeting of the Country Life Association in Washington, D. C., in November. It is probable that the near future, even as has the past, may bring calls for agricultural engineering service of a high character, and our Society should see that its members are well qualified for rendering such service as may be entrusted to them.

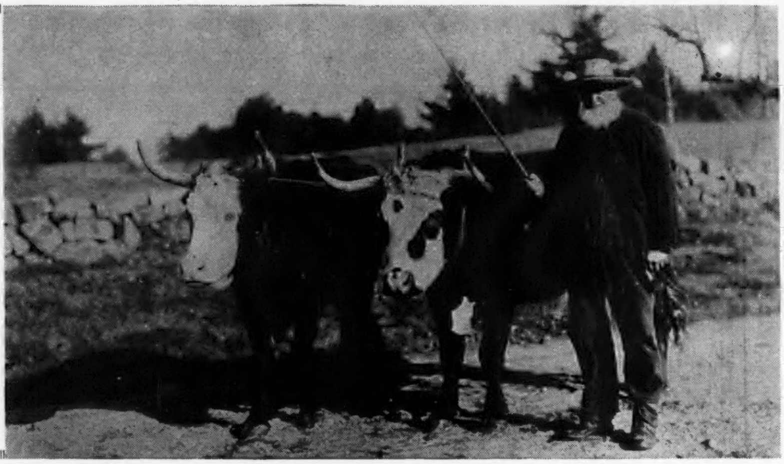
DEMANDS OF THE HOUR

There is great need for agricultural engineering research and efforts are being made to secure additional

[1]The annual address of the president of the American Society of Agricultural Engineers at the 23rd annual meeting of the Society at Dallas, Texas, June, 1929. Miscellaneous Series Paper No. 203, University of Minnesota, Department of Agriculture.

[2]Chief, division of agricultural engineering, University of Minnesota, Department of Agriculture. Charter A.S.A.E.

One of the most outstanding contributions which the engineer has made to agriculture is in the development and application of power. From the ox to the modern tractor is a long road—the engineer has traveled it with marked success



financial aid from the federal government for work of this character. One of the results of such research should be a lower cost of the production of essential food and clothing products. This result is necessary if the world is to continue to enjoy other products which American ingenuity has developed. Let us realize that the problem of continued prosperity becomes one of consumption as well as of production and it should be studied from both standpoints. Where, other than among agricultural engineers, shall we look for men able to guide such research? Probably there is no other field of work that offers greater opportunity for service to one's fellow men than does the field of agricultural engineering. However, this is not yet generally recognized and it is our responsibility to interpret to the world at large the zone of our activities.

Many of the contacts with men from all walks of life which I have made during my lifetime as an engineer, and especially since becoming president of the American Society of Agricultural Engineers, have indicated to me that most people do not clearly understand the meaning of the name engineer; hence, as our Society is taking a more and more prominent part in human affairs, I am convinced that it will be well for us to give some thought to the full meaning of the word, to take account of ourselves and to ascertain, as far as possible, just wherein our normal field of action as engineers lies.

Most persons think of an engineer as one who deals in the operation of a machine or an engine, such as a locomotive, but when you ask such a person where the locomotive comes from, he usually hesitates before replying, because he seldom stops to realize that the locomotive does not grow as does a plant or an animal, and it does not therefore occur to him at once to point out that it is a man-made contrivance, composed of materials provided by nature whereby the power stored up by nature in the fuel can be utillized to relieve the burden of man, thus adding to his happiness and that of his associates.

DEFINITION OF ENGINEER AND ENGINEERING

The designer of the locomotive is a professional or technical engineer and the locomotive engineer is an operating engineer, skilled more in time schedules, railway signals, and the operating of the locomotive than in the designing and building of locomotives.

American Engineering Council, organized in 1921 and composed of representatives of the technical engineering societies of the United States, defines engineering as "the science of controlling the forces and utilizing the materials of nature for the benefit of man, and the art of organizing and directing human activities in connection therewith." This is a clear and complete definition of engineering. In the light of this definition, it is a high privilege to be classed as an engineer for engineering is an occupation worthy of the utmost respect.

It is not my purpose to discuss either politics or religion as such, but politics should lead to good government and religion should lead to right living. Therefore, to this extent, at least, the engineer is interested in both of these subjects; but until he is well fortified with facts to prove a given hypothesis he must be content to seek patiently, with faith in the final outcome, for facts, on the assumption that any given political or religious tenet is good until he can point out that which is bad or false and thus more firmly establish the good and the true. An engineer loves facts, and once they are established in his mind, he will live by them and die for them, if need be, as it should be his constant desire to exert his energies for the benefit of his fellow men, not alone for himself as an individual.

The engineer, as a rule, becomes intensely interested in the continual search for facts and with these facts in mind, he should always endeavor to plan for better things. The engineer does not like to copy as he realizes that to do so is only to hold our own and means nothing in the line of human progress. To advance civilization, we must build better in the future than has been done in the past.

It is true that engineers, like all humans, are liable to err. Hence they do make mistakes especially on new or untried problems. Engineers, being but human, should always acknowledge their mistakes as they may thus guard against repetition of these mistakes by others. The old proverb 'By their fruits ye shall know them," is especially true of the engineer.

FORCES AND MATERIALS OF NATURE DEFINED

What are these great forces and materials of nature which we as men and as engineers are privileged to use? Under the head of forces should be included heat, light, gravity, chemical activity, animal power and electricity, and under materials, air and other gases, water, wood, minerals and metals, rock and clay products, petroleum, food, and clothing materials.

Man's moral and spiritual intelligence is the controlling principle. Man is a highly privileged character to be able to control these forces and to use these materials of nature for the benefit of himself and others. It is certainly true that man has been given a very high place in the works of the Creator, in that He has endowed man with directive intelligence. Man's control of natural forces is through his intelligence, in its turn continually influenced by certain moral and spiritual forces, the most prominent among which unquestionably is love, that which Dr. Henry Drummond has called "the greatest thing in

the world." As this moral force is therefore inseparably bound up with our actual and intelligent decisions regarding natural forces and their control, I believe we are fully justified at all times in considering it, conjointly with the natural forces on whose activities, through man's intelligence, it has, either by its presence or its absence, so marked an influence.

In an address, entitled "Science and Life," delivered by Dr. R. W. Thatcher, president of the Massachusetts Agricultural College, at the dedication of the Plant Industry Building at the University of Minnesota, June 7, 1928, he suggests tha t we adopt as a basis for scientific study of the phenomenon of life in this universe the classification of all things into five great kingdoms representing five stages of cosmic development. These are, in the ascending scale, beginning at the lowest; first, the mineral kingdom; second, the plant or vegetable kingdom; third, the animal kingdom; fourth, the kingdom of man; and fifth and highest, the kingdom of God. Everyone is already familiar with the customary use of the first three of these kingdoms as a basis of classification for the physical or material things of the universe. Dr. Thatcher proposes to add the last two in order to bring into the reign of an orderly study all of the facts and phenomena of the universe. We may doubtless properly assume that the ultimate purpose of any such scientific classification and study is an endeavor to safeguard human progress. Hence, as engineering activity is an essential factor of such progress, I believe that we as engineers will do well to accept this classification until we are able to point out a better or more logical one.

THE PERIODICITY OF CIVILIZATIONS

The development of earth's civilizations seems, throughout the ages, to have been periodic and distinctly limited. In an address, entitled "Civilization, Education, Peace," given before the American Society of Industrial Engineers in 1924, L. W. Wallace, executive secretary of the American Engineering Council, refers to a booklet, "Revolutions of Civilization," written by the eminent Egyptologist, William Flenders Petrie, who catalogs six distinct eras in each of which occurred a rise and fall of civilization. Right here permit me to quote at considerable length from Mr. Wallace:

"It is a striking fact that from 5400 B. C. to date the average period of each civilization is 1330 years. The shortest was 650 and the longest 1900 years. This period began about 1240 A.D. Consequently if it conforms to the law of averages, it will reach a low ebb about 2600 A.D., or some 600 years hence. Likewise if it conforms to the average it has about reached its peak of development.

"The state of sculpture, painting, literature, mechanics, science, and wealth were used by Petrie as a barometer for indicating the trend and status of civilization for any period. In the early periods the spread of time between a barbaric state and when a well-defined sculpture obtained was relatively long in comparison to the life of the civili zation period. Likewise the spread between each factor was short. In other words, in the earlier periods civilization developed very slowly and declined rapidly after reaching the peak. The gain in more recent periods has not been in the quality of the sculpture, painting, literature, and the like, but in a longer duration of such influences. Hence, it is that each civilization period has been an improvement over the foregoing, although the depth and height of its cycle may have been the same.

"What are the reasons for such cycles? Petrie tells us forms of government have had little influences. 'Regulation of daily affairs is of little meaning in civilization, when compared with the great formative interests of man's mind. What man does is the essential in each civilization; how he advances in capacities, and what he bequeaths to future ages. Man's advance in capacity and his contribution to future ages is dependent upon the extent and character of his education. In this connection education is used in its broadest sense, in the sense that Herbert Spencer had in mind when he said 'To prepare us for complete living is the function which education has to discharge.' Through complete living, man contributes the most to the upbuilding of the social, economic, industrial and political strata of the world and of the ages. Failure to live completely has been the underlying cause for the decline of civilization. The ease, comforts and luxury attending the peak points of civilization have been conducive to their own downfall. Many are looking with some alarm, therefore, upon the state of our modern civilization. Some are voicing the query: Has this civilization reached its peak, and, therefore, is it on the eve of a decline? If it conforms to the law of average, such is the case.

MAY THE LAW OF PERIODICITY BE OVERCOME—AND HOW?

"All that may save it or extend its period is the capacity of man. It is well, therefore, to examine into whether there are factors contributing to enlarge the capacity of man. Undoubtedly there are many. Education was never more universal than now. Science never was more active in its contribution to the sum total of human knowledge and understanding. Previously dark recesses of the unknown are being illuminated. The span of life is being extended; the vigor of its existence prolonged and made more pronounced. Agencies are available for annihilating time and space and, hence, immeasurably increasing the compass of man's activities, all of which means an enlarged capacity of the individual. Man of this civilization is therefore bequeathing enormously to future ages. This is certainly true in the realm of the physical. In the realm of the spiritual the evidence is not so clear. In the zone of the meeting of man's mind there are many clouds. They are evidenced by the jealousies, suspicions, and hatreds that exist among men and nations, by nations tenaciously holding to concepts that are not conducive to a meeting of national minds, concepts that are misunderstood, the backgrounds of which are not sufficiently illuminated to enable a proper evaluation of them. More light is required; that form of light that has so brilliantly illuminated the physical and scientific factors of the universe, that they are understood and controlled throughout the world. Education has been the medium of this conquest. It has drawn back the veil of ignorance, suspicion and fear; and disclosed knowledge, confidence and trust. An agency that has wrought so conclusively in other realms certainly offers much of promise in the zone of World Peace. Some form of international association for common education in my judgment, would be a potent factor 'for the removal of the prejudices and jealousies accumulated throughout the centuries.'"

The whole of Mr. Wallace's thoughtful address is well worth reading. I am glad to note that his hope for our present civilization lies in education, in which education I infer he includes right living based upon the fact that the pressing problem of the nations of the world is both an economic and a spiritual one. I have a very high regard for Mr. Wallace's opinions and I am wholly convinced that education of a fundamental and thorough character given to man in his early youth is the world's greatest need at the present time. This is especially true if we of this age are to be successful in the effort to stabilize and insure the continuity of present day civilization.

We are living in a wonderful age. The works of man in our present day civilization embrace a large and varied field of human endeavor. We probably are now at the highest stage of civilization that has ever existed on earth. It is certain that no civilization has ever before enjoyed the use of such inventions as the steam engine, the internal-combustion engine, the telephone, the radio, and the airplane. How much farther can we advance? Will we reach and maintain a normal

period, or will be again decline? I do not know. In my judgment it will depend upon the kind of lives the people live. I am an optimist; I hope and work for continually better things to come. We must realize that this is a matter for each individual to consider and each one should put forth his best personal effort to bring about a lasting and continually higher state of civilization.

THE PLACE OF THE AGRICULTURAL ENGINEER

In this task of safeguarding the present high state of civilization, the agricultural engineer holds a unique position. It is a position that lays upon him the responsibility of intelligently applying to rural life and to the agricultural industry those same forces of nature that have in recent times made enormous and significant changes in other lines of industry. We, as engineers, are assisting in awakening those engaged in agriculture to the evident fact that agriculture is an industry and that it is ceasing to be a mode of life. In fact, the whole business of production of food products in America is now an industry. Whether this is for better or worse we cannot yet say. In any case I doubt if we would care to check this trend of development if we could, for the use of power and machinery and efficient management have lowered the cost of many of the products of industry and they should lower the cost of the products of agriculture as well. The present prominent position of the agricultural industry is without doubt the result of the foresight and efforts of our forefathers. Its future rise or fall depends upon the thought and action of our own and following generations. The forces of nature are unchanged through the ages. The civilization of the people is what they make it and on them alone depends its longevity.

We should not become excited over changing conditions which have come about within the past few years largely through the development of the internal-combustion engine and electric power. This development of power apparently is a reward given to man for intelligent effort on his part. If its further use is rightly developed and rightly controlled, it should result in higher standards of living and a happier civilization.

THE INFLUENCE OF IMPROVED METHODS AND INDUSTRIAL MANAGMENT

The use of power and machinery should eventually lead to shorter hours of labor, a higher wage scale and a more agreeable task for each individual. Nature always returns a reward for intelligent effort. This reward as a rule does not come immediately, but it comes eventually as illustrated by the farmer planting good seed in fertile ground. He must first labor and sacrifice the seed. Then if he is faithful to the tasks of tillage and harvest as a rule nature will reward him with a substantial increase. While nature is kind, she is also just and the amount she will return to us for nothing is limited. Usually the reward is greater if we plan intelligently and then work according to our plan. This applies to any industry whether it be farming or manufacturing. Nature seems to regard the individual and not the group except through the individuals of which the group is composed and the law of averages indicates that there are a few superiors in each line of endeavor. This would indicate that all farmers are not equal in managerial capacity and that eventually those best qualified by nature and by self-improvement to manage farms would be the most successful. This fact together with the use of mechanical power may account for the present trend toward a larger size of farm unit, especially if the statement is true that most individuals work more efficiently under direction in any particular line of endeavor.

Nature apparently drives man to seek to raise his standard of living in his pursuit of happiness. In the early ages of man she kept him occupied in seeking food and clothing, but through the development of his intelligence and his use of the forces and materials of nature he has come to desire more than mere food and clothing. He is learning to use his leisure time to increase the joy of life and to live more nearly in keeping with nature's laws. He is being rewarded for his efforts. Men in all stations in life and with leisure time to enjoy them are now enjoying the use of automobiles, telephones, electric light and power, radio, motion pictures, airplanes, television, etc., who only a few years ago were seeking much of their enjoyment in sadly limited hours of leisure through unproductive personal practices, the capacity of which for furnishing enjoyment was to say the least doubtful.

THE FUNCTION OF WEALTH

In our age too many persons are looking to great wealth for happiness but, while wealth is desirable, it should be considered as a symbol of human effort and its possession or expenditure should be considered as a sacred trust. Wealth should not be hoarded nor should it be expended foolishly. Apart from its intimate relationship to the well-being and happiness of its possessor, it is a means for giving employment to those in need of employment. To give employment to persons needing it and to endeavor to teach them how really to live is the highest kind of citizenship or service.

In the working out of man's problems there is usually but one answer which is right and which therefore will endure while there may be millions of answers which are wrong. Wrong answers indicate carelessness, false instructions, laziness and guessing. Youth should be taught

"The use of power and machinery should eventually lead to shorter hours of labor, a higher wage scale and a more agreeable task for each individual," says Mr. Boss, and adds, "Nature always returns a reward for intelligent effort."

that a just reward comes from consistent and honest endeavor and that one should not expect to get something for nothing. More money should be spent on our elementary schools, for the right kind of teachers, and in teaching the fundamentals of right living and a wholesome interest in and respect for honest labor.

THE REAL SOLUTION OF THE SURPLUS PROBLEM

America is a producing nation, producing both agricultural and manufactured products, and, due to the use of mechanical power and machinery, we have a tremendous productive capacity which has not yet reached its normal maximum. These facts are largely the cause of our surplus problem. The only permanent solution of this problem lies in seeking methods to reduce to a minimum the cost both of production and distribution and at the same time in increasing the consuming or purchasing power of every individual in all walks of life. Such a step is particularly essential at this time for the well-being of the agricultural industry. This solution calls for shorter hours of labor and higher wages coupled with a desire to expend these wages in owning a home, raising and educating a family, and in seeking types of enjoyment of leisure hours that tend to raise the moral, intellectual and social standards of the individual. The cherishing and realization of such a desire is the clearest possible indication of real American citizenship. Labor has been struggling for generations, more or less blindly to be sure, for the realization of this higher stage of progress, and in the present day most leaders in industry seem to have learned that to demand from labor excessively long hours at low wages does not pay. They have been forced to recognize that the highest lasting good to themselves is inseparable from the good of society as a whole. Captains of industry have learned that it is good business and for the best interests of the community as a whole to employ a workman under efficient direction for shorter hours and at higher warges, and provide him with good tools and proper equipment, thus not only enabling him to earn sufficient to raise and educate his family and eventually to own his own home, but also allowing him a reasonable leisure in which to get some joy out of his home and out of a wholesome association with his family and his friends.

The statement is often heard that we are now living in a "machine age." This statement is misleading as it implies that more thought is being given to machines than to life. Machines are simply tools whereby the forces and materials of nature are utilized for the benefit of man. A normal man is not a machine. The making of machines, however, serves to give employment to persons mechanically inclined and who unless thus or otherwise employed would eventually be forced to return to agriculture to make a living, as agriculture or the production of food is the first need of man in sustaining life. The right use of mechanical power will reduce man's physical labor and increase his earning capacity. While general industry in America has never been so prosperous as in the past few years and while there has never been such a variety of work as at the present time, agriculture has not shared equally in this prosperity. A readjustment much more favorable to agriculture should be sought. Even when this has been done in order to extend prosperity to all groups and to insure its continuity the purchasing power of the individual citizen must be maintained at a high level as he is the ultimate consumer both of agricultural and of manufactured products. For him eventually to own his home, to raise and educate a family, the members of which consume and enjoy the products of both farm and factory and take an interest in the life and development of the community is to safeguard our great America and point the way for foreign nations in the recognition that parenthood, supported by proper fundamental education, leads to the highest type of contentment and happiness.

The development of an era of better farm homes, or of suburban homes located adjacent to improved highways, for both rural and industrial workers, the brightening of the daily life with modern home conveniences and contacts with nature through home production of flowers, fruits, and animal pets; the fostering of the "family idea" and the "own your own home" spirit and the encouraging of a reasonable leisure devoted to enjoying life would do more to provide wholesome employment and to insure continued prosperity for all than could any possible legislative plan for the fixing of prices or the control of surpluses.

I wish seriously to raise the question whether we, the American Society of Agricultural Engineers, as a group could set for ourselves a higher or more desirable goal than the realizing of such a state of rural life in America. Says George Eliot, that great limner of human character, "What do we live for if it is not to make life less difficult to others."

Chemical Sterilization

THE constantly increasing demand for better sanitation in the handling of food products has increased the demand for more effective methods. For many years practically the only means recognized for sterilizing utensils and equipment in the food and dairy industry was heat. When properly applied heat is an effective means for sterilization and by its proper use food containers and equipment can be rendered reasonably sterile.

Since the sterilization of drinking water by chlorine is now standard sanitary practice, there was every reason to believe that the use of chemicals might be extended to include sterilization of dairy utensils, food containers, dishes in public eating places, and other equipment. In large dairy plants where properly controlled experiments were conducted, it was found that lower bacterial counts were obtained where chemicals of the chlorine type were used than where steam or hot water were used. Where the two methods were alternated over a period of six months, using chemical methods one week and heat methods another, the results were greatly in favor of the chemical methods. A decided decrease in bacterial count was noted under the chemical method. Where it was common to have a count of 10,000 to 100,000 bacteria per cubic centimeter, this was reduced by chemical sterilization to about 1000. Very rarely did it exceed 5000.

Chemical sterilizers are applied by simple and inexpensive methods. Small pieces of equipment can be rinsed thoroughly. Large pieces or large surfaces can be sprayed. To make the sterilization effective the surface should be in contact with the chemical about one-half minute. Care must be exercised in keeping the strength of the chemical solutions up to a specified standard.

Health departments have been quick to recognize the greater efficiency and decided advantages of chemical sterilization. In many instances the regulations have been revised to include the use of chlorine sterilizers. Since we now have a better understanding of these methods, and such excellent results are being demonstrated, a brilliant future is confidently expected for this system of sterilization. In the demand for greater efficiency and decreased costs it would not be surprising if in a few years steam and hot water sterilization were very largely supplanted by the newer chemical methods.

The manufacturers of food products will of course need to continue the use of heat for sterilization of the products themselves; but by chemical means they may readily secure sterile equipment and containers.—From the "Industrial Bulletin" of Arthur D. Little, Inc.

Drying Alfalfa Hay by Forced Draft with Heated Air[1]

By W. M. Hurst[2] and T. A. Kiesselbach[3]

ALFALFA plants when cut for hay usually contain from 70 to 80 per cent moisture. Except for immediate shipment in box cars, the hay is sufficiently dry to bale when the moisture content has been reduced to 20 per cent. It follows, therefore, that to secure a ton of alfalfa hay having a moisture content of 20 per cent about 2 tons of water must be evaporated.

The rate at which this moisture is evaporated under natural conditions depends in part upon the temperature and relative humidity of the surrounding air and the methods employed in curing the hay. During the curing or drying process, weather conditions are frequently unfavorable, resulting in low grade hay or even a complete loss of the crop. For this reason it seemed desirable to investigate the possibilities of drying hay artificially.

EXPERIMENTAL METHODS

Experimental hay-drying equipment was set up at Lincoln, Nebraska, and a series of tests was made in 1928 to determine some of the factors involved in drying alfalfa hay by forced draft with heated air. The drier was designed to dry samples of hay for physical and chemical analysis, and to obtain information regarding the time and heat requirements for drying.

Fig. 1 is a diagrammatic drawing of the equipment used. The drier consisted of a box 4 feet high and 3 by 4 feet in section, open at the top except for a removable screen-bottom tray. The box, made of 1-inch boards, was lined with sheet metal to prevent heated air from escaping through the sides. The drying air was forced into the box near the bottom and up through the hay by a multiblade fan. A damper was placed on the intake side of the fan to control the quantity of air supplied. Heat was supplied by an electric heater made up of forty-eight 300-watt elements in an insulated heater box. The air was forced through 13 feet of 7-inch pipe to the heater box from which it passed into the drier. A long section of pipe was used to facilitate accurate air measurements. The air velocity in the pipe was determined with a Pitot tube at the center of the pipe at a point about 12 feet from the fan. A watt-hour meter was used to determine the amount of energy required to heat the drying air.

At the beginning of each test about 25 pounds of green alfalfa was placed in the screen-bottom tray. The green forage filled the tray to a depth of about 10 inches. As the hay dried it settled down to a depth of about 6 inches. The hay was weighed at 30-minute intervals to determine the rate of drying. For the purpose of determining approximately the weight of the hay at the desired moisture content it was assumed that the green alfalfa contained 73 per cent moisture when placed in the tray. This estimate was based on the results of previous investigations. The weight of the samples when sufficiently dry was computed on this initial moisture content basis and the drying operation continued until the desired weight was reached. A slight variation in the moisture content of the 25-pound sample of green hay made a considerable difference in the moisture content of the final product when computed on a weight basis. For this reason the samples were not all reduced to the same moisture content. At the end of each test a composite sample of hay was taken for moisture determination and chemical analysis. The remaining hay, which was usually about 7 pounds, was later graded by the Division of Hay, Feed and Seed of the U.S.D.A. Bureau of Agricultural Economics, in accordance with the federal standard.

HEAT UNITS REQUIRED

The relation betwen the moisture content and the hay and duration of drying at different temperatures and air velocities is shown in Fig. 2 for ten of the tests. During several of the tests the hay was not reduced to 20 per cent moisture. Where this condition existed the curves have been extended to show the approximate time required for that amount of drying. The percentage of moisture in the hay at different times during the tests was computed from the weight of the hay at 30-minute intervals based on the analysis of the composite sample taken at the end of each test. The computed moisture content of the green plants checks very closely with data obtained in previous investigations[4].

Fig. 2 shows a considerable variation in the time required to dry hay under the test conditions. As would be

[1]A report based on experiments made cooperatively by the Nebraska Agricultural Experiment Station and the Bureau of Public Roads and the Bureau of Plant Industry, U. S. Department of Agriculture. Released for first publication in AGRICULTURAL ENGINEERING.

[2]Assistant agricultural engineer, Division of Agricultural Engineering, Bureau of Public Roads, U. S. Department of Agriculture. Assoc. Mem. A.S.A.E.

[3]Professor of agronomy, College of Agriculture, University of Nebraska.

[4]Kiesselbach, T. A., and Anderson, A. Alfalfa Investigations, Nebraska Agricultural Experiment Station Research Bulletin 36 (1926).

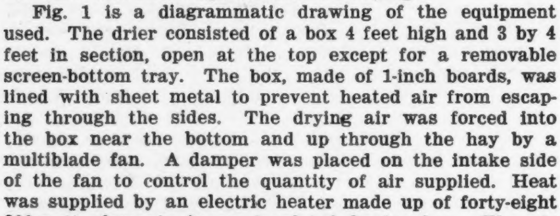


Fig. 1. A diagrammatic drawing of the equipment used

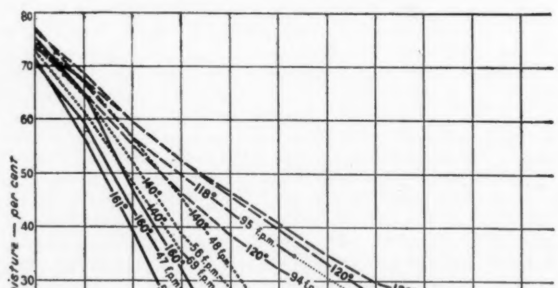


Fig. 2. Rate of drying alfalfa hay as affected by temperature and air velocity

TABLE I. HEAT UNITS SUPPLIED IN DRYING GREEN ALFALFA PLANTS TO 20 PER CENT MOISTURE WITH THE DRYING AIR AT DIFFERENT TEMPERATURES AND VELOCITIES

Test No.	Green Alfalfa Plants[1]		Alfalfa Hay		Temperature, approx.	Drying Air				Heat Supplied by Heater	
	Weight	Moisture	Weight	Moisture		Relative humidity	Rise in temperature	Velocity, approx.	Water Evaporated	Per pound of hay[2]	Per pound of water evaporated
	Pounds	Per cent	Pounds	Per cent	Deg.F.	Per cent	Deg. F.	f.p.m.	lbs.	B.t.u.	B.t.u.
202	25.0	77.1	7.1	20.0	118	21	33.8	95	17.9	24,201	9,694
228	24.8	73.9	8.1	20.0	120	18	28.7	94	16.7	18,562	8,964
265	25.0	73.3	8.3	20.0	120	11.9	41.2	68	16.7	22,665	11,326
230	25.0	76.6	7.3	20.0	121	19.7	33.7	67	17.7	17,494	7,215
229	25.0	75.9	7.5	20.0	130	14.2	43.9	74	17.5	15,397	6,649
209	25.0	74.4	8.0	20.0	140	10.0	49.0	48	17.0	9,684	4,549
223	25.5	72.8	8.7	20.0	140	10.5	48.4	69	16.8	11,715	6,035
245	24.8	74.0	8.0	20.0	140	10.5	46.0	56	16.7	10,594	5,097
256	25.0	71.8	8.8	20.0	150	5.5	64.5	50	16.2	10,776	5,885
255	25.0	75.6	7.6	20.0	160	4.5	76.1	42	17.4	10,601	4,657
263	25.0	70.6	9.2	20.0	160	4.5	70.2	47	15.8	8,676	5,052
246	24.5	71.7	8.7	20.0	161	6.1	60.6	57	15.8	7,801	4,280

[1]Plants three-fourths to full bloom [2]Hay of 20 per cent moisture

expected, the hay dried much faster with air at 160 degrees (Fahrenheit) than at either 140 degrees or 120 degrees. The rate of drying at a given temperature is also shown to depend in part upon the velocity of the drying air entering the hay. The air velocity as shown in Fig. 2 and Table I was determined by dividing the average number of cubic feet supplied per minute by the cross-sectional area of the tray with corrections for increase in volume due to temperature. The actual air velocity through the hay was higher than that shown due to the space occupied by the hay. The temperature and velocity of the drying air as shown is the average for each test.

The number of heat units supplied in drying the green alfalfa plants to 20 per cent moisture is shown in Table I on the basis of B.t.u. per pound of water evaporated and per pound of hay at 20 per cent moisture. Since the samples were not all dried to the same moisture content, this table has been prepared from the data shown in Fig. 2 and Table II as a means of comparng the different tests. The weight of the hay at 20 per cent moisture was computed from the analysis of the composite samples as shown in Table II. The number of pounds of water evaporated was determined by substracting the weight of the hay at 20 per cent moisture from the weight of the green plants at the beginning of the tests. The total number of heat units supplied in heating the air (not shown in the table) were obtained by multiplying the number of kilowatt-hours of electric energy used in drying the hay to 20 per cent moisture by 3,412 (B.t.u. per kilowatt-hour). The product was divided by the pounds of water evaporated and by the pounds of hay at 20 per cent moisture to secure the number of B.t.u. per pound of water evaporated and per pound of dry hay, respectively.

TABLE II. PROPERTIES OF TWELVE SAMPLES OF ARTIFICIALLY DRIED ALFALFA HAY AS COMPARED WITH HAY CURED IN THE FIELD UNDER FAVORABLE CONDITIONS[1]

Sample No.	Moisture Content Beginning of test[2]	Moisture Content End of test	Time required approx.	Temp. of drying air, approx.	Grade No.	Color	Stem Quality	Protein content (Moisture-free basis)
	per cent	per cent	Min.	Deg. F				per cent
202	77.1	34.6	160	118	S.Moldy[3]	65	Pliable	20.3
209	74.4	27.0	135	140	S.Musty[3]	65	"	20.9
223	72.8	25.0	120	140	1,Ex.L.[4]	70	"	20.3
228	73.9	21.8	225	120	1,Ex.L	70	"	21.6
229	75.9	23.6	150	130	1,Ex.L.	65	"	21.4
230	76.6	24.6	225	121	1,Ex.L.	70	"	21.4
245	74.0	19.6	150	140	1,Ex.L.	65	"	20.7
246	71.7	13.2	105	161	1,Ex.L.	65	"	20.1
255	75.6	15.8	120	160	1,Ex.L.	65	"	20.2
256	71.8	14.4	150	160	1,Ex.L.	65	"	19.9
263	70.6	8.0	150	160	1,Ex.L.	70	"	19.6
265	73.3	21.6	300	120	1,Ex.L.	65	"	19.4
Average all hay cured by artificial heat					1,Ex.L.	67	"	20.4
264 Hay cured in shade under cover					1,Ex.L.	65	med.hard	20.9
237[5] Hay cured by combined swath and windrow method					1,Ex.L.	60	pliable	19.5

[1]Samples graded several months after drying experiments had been conducted

[2]Alfalfa three-fourths to full bloom

[3]Sample grade. These samples would have graded No. 1 Extra Leafy if they had been sufficiently dried when placed in pasteboard boxes

[4]1, Ex. L. is U.S. No. 1 Extra Leafy grade

[5]Hay cured four hours in swath, then left in windrow until fully cured. Average for eight adjacent plats cut July 23, 9:00 a.m. and graded and analyzed individually. They represented medium size windrows raked with both sulky and side-delivery rakes. The cured hay in these plats averaged 48 per cent leaves compared with 52 per cent in the other cases where no leaves were lost

A considerable variation is shown in the number of heat units supplied in accomplishing approximately the same results in different tests. With only one or two exceptions, an increase in temperature was followed by a decrease in the number of heat units supplied per pound of water evaporated and per pound of hay dried. The temperature of the hay increased as it dried, thus increasing the temperature at which water was evaporated. Due to this variation in temperature throughout each test and to the fact that the water was not evaporated from a free surface it would be impossible to determine accurately the heat units necessary to evaporate moisture under the test conditions. It would appear, however, that less than 25 per cent of the heat supplied in heating air was utilized in evaporating moisture. A greater part of the heat was lost in the exhaust air as no provisions were made for recirculation.

About 7,800 B.t.u. were required per pound of dry hay for the test showing the lowest total heat requirement. At this rate about 0.56 pound of coal with a heat value of 14,000 B.t.u. would have been required per pound of dry hay assuming that no heat was lost from the products of combustion. On this basis the equivalent of 1,120 pounds of coal would have been required per ton (2,000 pounds) of dry hay. The efficiency of the drier could doubtless be increased by recirculating the drying air, but the efficiency of the coal or coke burning furnace suitable for drying hay would be considerably less than 100 per cent.

QUALITY OF PRODUCT

The commercial grade, color, stem quality, and protein content of the hay resulting from the various artificial heat drying tests are shown in Table II. For comparison the results with corresponding hay made under favorable field conditions by combined swath and windrow curing, and also with cover-cured hay, are included. All of the forage involved was second cutting alfalfa in the three-fourths to full-bloom stage of maturity, grown in a rather uniform portion of a four-year-old meadow. The field and

cover-curing tests began July 23, while the artificial curing extended from July 24 to July 29. The field curing practice involved 4 hours in the swath, followed by raking into medium-sized windrows. An average of 54 hours were required after cutting to reduce the forage to 22 per cent moisture.

It is evident that very choice hay was produced by all combinations of the artificial drying. The commercial grade averaged "No. 1 Extra Leafy" alfalfa, which is the highest federal grade. The color and odor were choice; the stems were soft and pliable; and the protein content averaged 20.4 per cent. The extreme range in protein was from 19.4 to 21.6 per cent. The variation may be due in part to field variability and in part to advancing maturity as the experiment progressed.

The field-cured hay graded equally good and its description was as favorable except for 7 per cent inferior color and 1.0 per cent lower protein content. These slight shortcomings were doubtless caused by sun bleaching and leaf shattering. Naturally all of the leaves could be retained by the artificial drying method. Such drying resulted in only 0.4 per cent lower protein than was obtained under the experimental conditions of slow shade-curing in the hay barn where no leaves were lost. This difference would seem to be within the limits of experimental error.

It is concluded that the principle of rapid control drying in no way increases the actual protein content over that of the fresh forage as has sometimes been suggested, but, on the other hand, no protein is lost through waste of leaves, as may occur in varying degrees under field-curing conditions. There is no reason to suspect a modification of either the palatability or nutritive value of the forage produced by rapid curing at the range of temperature herein used as compared with natural curing under favorable field conditions except that associated with loss of leaves. The field-curing condition must, on the other hand, be exceptionally favorable to produce equally choice hay.

It is readily seen from the data in Table III how a loss of leaves may affect the feeding value of the hay. Compared with the stems during a four-year period, the leaves contained 38 per cent more minerals; 132 per cent more protein; 11 per cent more nitrogen free extract; 123 per cent more fat, and only 41 per cent as much crude fiber. Since No. 1 leafy alfalfa hay must contain at least 50 per cent leaves by weight, and since overcuring in the field may frequently serve to lower the grade to No. 2 or No. 3, the serious aspect of such loss to the feeding and market value becomes apparent. Mustiness due to rains and unfavorable drying weather is another common loss that would be avoided through artificial drying.

ECONOMIC CONSIDERATIONS

One mode of appraising the market value of different grades of alfalfa hay is through a comparison of actual prices paid at the terminal markets. Such data are supplied in Table IV, in which the prices per ton in carload quantities at Kansas City, Mo., are given for the years 1927 and 1928. It will be noted that several grades were not offered throughout the twelve months in 1927 and the averages should be considered accordingly. A greater part of the alfalfa hay sold on the Kansas City market falls within No. 2 and No. 3 grades. In 1927 the average price of U. S. No. 1 Extra Leafy alfalfa is shown to be $6.08 higher than for U. S. No. 2 alfalfa. In 1928 this difference was $8.94. Calculated for the five months of August to December, inclusive, during which all grades were represented, the difference betwen these two grades was $6.65 and $7.45, for 1927 and 1928, respectively. With these grades and prevailing prices, artificially dried hay might be expected to bring from $6.00 to $7.00 per ton more than the average price for field-cured alfalfa hay because of its superior quality. It has been estimated that approximately 25 per cent of the alfalfa crop in the central states is seriously damaged annually by unfavorable weather conditions. This loss in terms of market value is estimated as equivalent to an average of about $4.00 per ton, which might be saved by artificial drying. The difference between the price of high quality hay and that of hay severely damaged by unfavorable weather conditions would probably amount to from $10.00 to $11.00 per ton at Kansas City. From estimates it would appear that $10.00 to $11.00 per ton might be considered as the maximum allowable cost for artificial drying, provided other expenses were comparable. Should the artificially dried hay fail to be sufficiently leafy to grade above No. 1, these price advantages would be lowered $2.00 to $3.00 per ton.

The tests show that a high quality hay (U.S. No. 1 Extra Leafy alfalfa) was secured under the test conditions, but the necessity of evaporating 2 tons of water to secure 1 ton of dry hay demands the expenditure of considerable energy. Wilting the freshly cut hay in swaths previous to drying has been suggested as a means of reducing the cost of drying.

TABLE III. Comparative Composition of the Leaves and Stems of Alfalfa During 4 years, 1921-24*

Portion of Hay	Ash	Protein	Fiber	Nitrogen Free Extract	Fat
	%	%	%	%	%
Leaves	11.71	25.89	16.74	41.60	4.06
Stems	8.47	11.14	41.04	37.53	1.82
Ratio of leaves to stems	1.38	2.32	0.41	1.11	2.23

*Summarized from Table X of Neb. Ag. Exp. Sta. Res. Bull. 36

TABLE IV. CARLOAD PRICES OF ALFALFA HAY BY GRADES - KANSAS CITY, MO., MARKET[1]

	Prices by Months - Average per Ton												Avg. Price by grades	
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Twelve months	Aug. to Dec.
	1927													
U.S.No.1 Ext.Lfy.	--	--	--	--	--	--	--	$17.00	$20.25	$22.25	$21.50	$24.00	$21.00	$21.00
U.S.No.1	$20.00	$19.25	$18.75	$19.00	$19.00	$15.00	$14.75	15.25	18.00	19.50	20.00	22.25	18.40	19.00
U.S.No.2 Lfy.	--	--	--	--	--	--	--	14.00	16.00	17.75	16.50	18.00	16.45	16.45
U.S.No.2	17.50	17.00	15.75	16.25	16.25	13.00	11.50	12.25	13.50	14.50	15.00	16.50	14.92	14.35
U.S.No.3	14.50	13.75	13.00	12.50	12.50	10.50	10.75	10.25	10.50	10.75	10.50	11.50	11.75	10.70
	1928													
U.S.No.1 Ext.Lfy.	25.50	27.25	30.00	33.50	31.50	23.00	23.50	24.25	24.75	25.75	28.00	29.50	27.21	26.45
U.S.No.1	21.50	22.50	24.25	26.00	26.00	20.00	20.00	20.50	21.00	23.25	25.00	26.00	23.00	23.15
U.S.No.2 Lfy.	19.75	19.75	21.75	23.75	23.75	19.00	18.25	19.75	19.25	21.25	22.75	24.25	21.10	21.45
U.S.No.2	15.25	16.25	18.75	20.50	21.50	16.00	16.00	16.75	17.25	19.00	20.00	22.00	18.27	19.00
U.S.No.3	11.50	11.50	13.75	15.25	17.50	--	12.75	12.50	12.75	14.75	15.75	17.75	14.16	14.70

[1] Market News Service, Hay, Feed & Seed Division, U.S.D.A.
Bureau of Agricultural Economics - Crops and Markets

Anti-Friction Bearings in Farm Equipment

By L. M. Klinedinst[1]

SINCE its beginning farm machinery has gone through two distinct phases of development. The first may be considered as extending from its earliest days to the point where tractors became an accepted source of motive power. The second is the one existing at present. The introduction of the tractor just about revolutionized both the mechanics and economics of farm operation, but it also raised a whole set of new problems in connection with machine construction and design. More power, and greater operating speeds, became available, which, in brief, meant that a given machine could produce more work at a considerable saving in overall operating cost. Before full advantage could be taken of these possibilities, however, it was necessary to effect changes in the design and construction of the machines themselves. More power and greater speed meant a proportionate increase in the severity of the service requirements, so much so, in fact, that unless machine design was conditioned to them much of the gain promised would be offset by mechanical troubles within the machine.

Naturally, under such conditions, one of the first problems that came up for consideration was that of fricition reduction. Generally speaking the farm machine, practically regardless of type, is primarily a friction load on the prime mover, whether it be haulage or driving, or both. With increased speeds and heavier loads the friction problem became acute, and, in addition, other factors began to make themselves felt. Questions of shaft rigidity, or alignment, or thrust loads, although they had always existed, attained considerable prominence under the new conditions. All of these questions resolved eventually into one of bearing selection, since the proper form of bearing is, in most cases, the universal answer to all of them.

It is hardly surprising under the circumstances that machine manufacturers turned to the anti-friction bearing as a solution of their problems. The effect of such bearings on the friction characteristics of the machines alone was enough to justify their application, but experience soon proved that their influence went much further than that. Properly selected and applied they reduced operating expenses by lowering fuel consumption, effecting savings in lubrication, and making higher speed safe for the machines. They also cut maintenance expense by preserving the proper alignment of shafts, preventing shaft wear, and maintaining original adjustments of various parts, thus prolonging the life of the parts and adding to the effectiveness of the machines as well.

The engineering problems involved in applying anti-friction bearings to farm equipment of various sorts are

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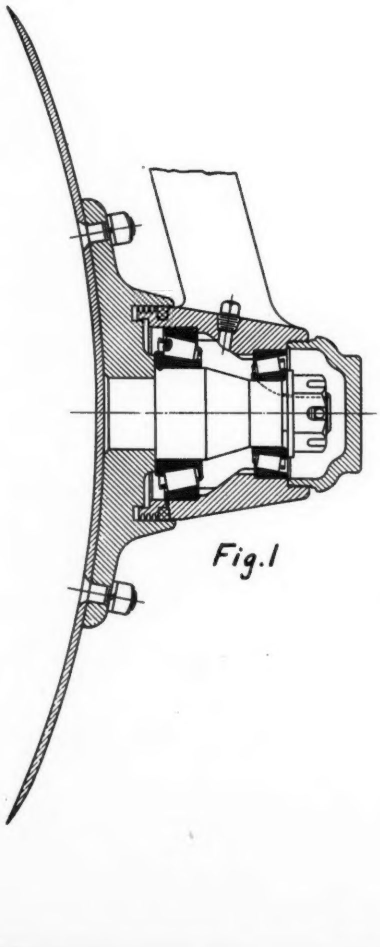


Fig.1

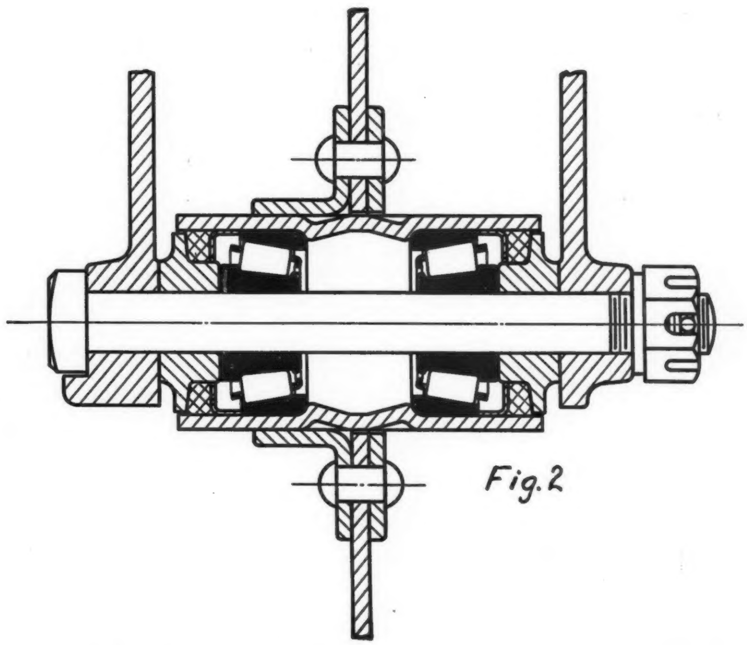
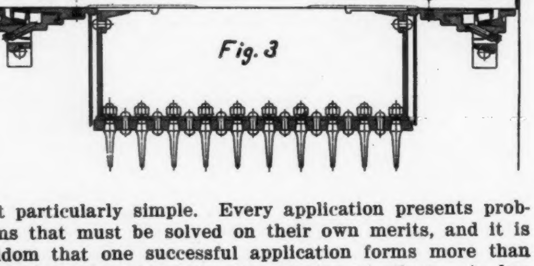
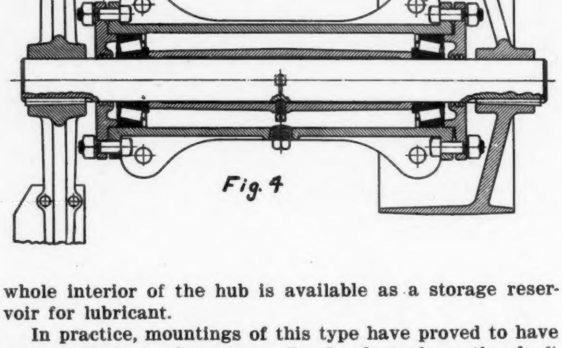


Fig.2

Fig. 1. (Left) A typical bearing layout for a disk plow hub showing the ample space for lubricant storage and the form of closure adopted to exclude dirt. Fig. 2. (Above) Bearing mounting for a rolling coulter. The arrangement is characterized by its simplicity and strength

Fig. 3. (Below) Typical mounting for a thresher cylinder. The boxes are self-aligning, and the closures very effective against the entrance of dirt or the escape of lubricant. Fig. 4. (Right) Bearing mounting for the wind stacker shaft of a threshing machine





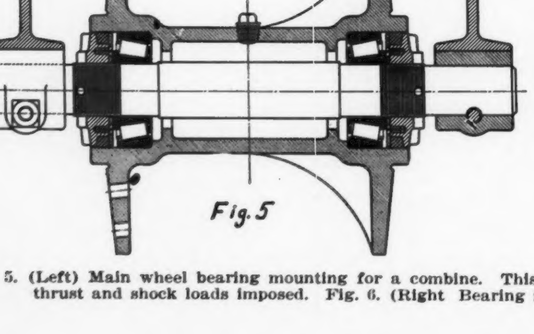
not particularly simple. Every application presents problems that must be solved on their own merits, and it is seldom that one successful application forms more than the barest precedence for the solution of others. As has already been intimated there are a good many factors beside the matters of load and speed that must be taken into consideration, since they exert a decided influence on the suitability of the bearing for any particular point of application. In spite of these apparent difficulties, applications involving the use of anti-friction bearings have been worked out for practically every class of farm power equipment where such bearings have any place at all. Since both the factors governing the method of application vary considerably among machines, or even among different points in the same machine, it may be of interest to consider some of them in detail, especially so considering the effect of the bearings on the overall efficiency of the machine.

Disk Plows. From a bearing standpoint disk plow service is characterized by heavy sustained thrust loads, complicated by severe shock loads whenever the disk strikes a stone or similar obstruction in the soil. There is also a continuous bending stress on the spindle, which resolves itself into a crushing load on the bearings at that point. The bearing arrangement that has been developed for this service is shown in Fig. 1. As can be seen, it is quite simple; the cones, or inner races are given a light press fit on the shaft, and the cups pressed into the disk hub. A bearing of sufficient capacity to withstand all the strains to which it is subjected is used at the point nearest the disk. The whole assembly is set up and locked in place by a single nut and washer arrangement at the end of the shaft as shown, by the use of two nuts with tongue washers between them. The closures are designed to be dirt and lubricant tight; the closure next to the disk, where the accumulation of dirt is liable to be greatest, is built up of felt and annular grooves properly protected so as to give reliable service. The whole interior of the hub is available as a storage reservoir for lubricant.

In practice, mountings of this type have proved to have several distinct advantages. In the first place, the draft of the plow is decreased anywhere from 20 to 35 per cent, depending somewhat on exterior conditions. Furthermore the freer turning of the disk, which for a given tractor speed gives a disk speed of about twice that with plain bearings, helps to improve operation. Trash and litter have much less opportunity to jam around the disks, and the latter clean themselves much more readily. The lubrication problem is also considerably simplified, both as to application and effectiveness. It is usually only necessary to apply the proper amount at the beginning of the season, instead of having to renew it every few hours during operation.

Another plow application which is simpler both as regards service and mounting is that to rolling coulters, shown in Fig. 2. In this case the bearing cups are pressed into a specially designed sleeve which is indented to form locating shoulders, and the cones are given a light fit on the shaft. The whole set-up is located by collars on the shaft, which form the outer closures, and a castellated nut at the end of the shaft. There is a large space available for lubricant, and the closures form an effective seal against its escape. The whole forms an inexpensixe, but effective mounting, the advantages of which are fairly obvious.

Threshers and Combines. Since the work done by machines of this class, and consequently the bearing problems involved are practically similar, they will be considered together. In fact, about the only difference is that the service requirements of combines are somewhat more severe. Of all the numerous applications made to machines of this type probably the most important, and the most difficult from the standpoint of service problems, is that of the cylinder shaft. Operation at comparatively high speed is continuous, the loads both radial and thrust



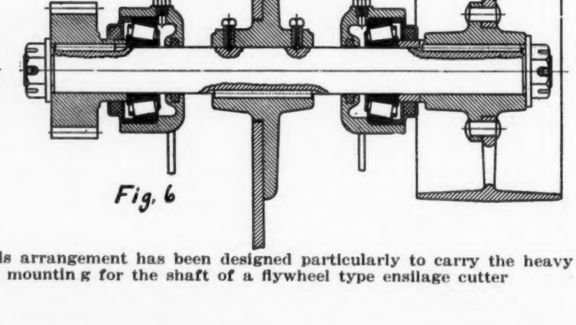


Fig. 5. (Left) Main wheel bearing mounting for a combine. This arrangement has been designed particularly to carry the heavy thrust and shock loads imposed. Fig. 6. (Right Bearing mountin g for the shaft of a flywheel type ensilage cutter

are heavy and apt to fluctuate, and, what is vitally important, the shaft settings must be maintained accurately throughout operation. To analyze the loads encountered, there is of course a sustained radial load subject to sudden peaks when the machine is fed unevenly. There is also a heavy thrust load caused partly by belt tension and partly by the passage of the grain between the teeth of the cylinder and those of the concave. The latter is liable to rise to considerable proportions if the material develops a tendency to jam between the teeth, because of damp straw, crosswise feeding, weeds, etc. And in addition to the foregoing, the surrounding conditions are about as bad as possible, as far as flying dust, or dirt, or bits of straw are concerned.

A typical bearing arrangement for applications of this character is shown in Fig. 3, which is remarkably simple, considering the service requirements. The bearings are mounted in housings that are self-aligning to compensate for weaving and distortion in the machine frame. The bearing cones are pressed on the shaft and located by sleeves that are pinned against slippage. The cups are given a light fit in the housing and are located by the outer closure. One of the interesting features of the mounting is the form of closure that has been adopted. The inner closure, where the accumulation of dirt and chaff is naturally greatest, is a labyrinth grease seal, designed to exclude the finest dust and to prevent the escape of lubricant. The outer closure is simpler, but quite effective. As a result of the lubrication provisions, the lubrication requirements drop from constant attention to periodic attention, and all danger from hot boxes is eliminated.

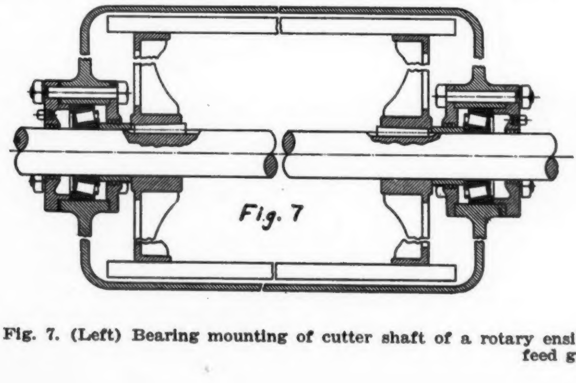
Among the other numerous shafts in both threshers and combines that have been successfully equipped with anti-friction bearings, the windstacker or blower shaft in threshers is of interest. It may also serve as an example of the mounting procedure followed in most of the others, such as crankshaft, fan or beater shafts, or power take-off shafts. A typical windstacker shaft mounting is shown in Fig. 4. Since the requirements in this case are comparatively simple, the mounting is correspondingly simple. The bearing cones are given a tight press fit on the shaft, being located by a spacing sleeve that is pinned to the shaft. The cups are given a light fit in the hub, and the bearings are properly set up by shims between the hub and the outer closure. The whole makes a simple, inexpensive mounting, easy to assemble, and not requiring specially costly machine work. It can be seen that the whole interior of the hub is available for lubricant storage, and that the closures though simple are effective.

A mounting of considerable importance in combines is that on wheels, especially main wheels. The speeds are not particularly high, but the loads are heavy and sustained. In addition, the bearings are subjected to sudden, severe shock and thrust loads caused by the passage of the wheels over inequalities in the surface of the field. Crossing a deadfurrow, for example, is liable to cause practically the whole weight of the superstructure to shift, so that a heavy sideways load is suddenly imposed on the wheel bearings. A typical application of this sort is shown in Fig. 5. The bearing cups are pressed into the wheel hub, and the cones given a sucking fit on the shaft. The bearings are set up by the outer closures, which are screwed onto the shaft and locked in place by cotter pins. The construction provides ample space for lubricant storage.

In conclusion, it might be said that the mechanical and practical advantages of all these mountings are quite easily summed up. Power consumption is lowered, higher shaft speeds are made possible and safe, and the effectiveness of the machine as a whole is increased. On the other hand, lubrication expense is lowered and, what is probably even more important to the user, the time necessary to apply lubricant is reduced to a negligible quantity. The measure of the benefits actually obtained is of course dependent upon the degree of completeness to which the machine as a whole is anti-frictionized.

Ensilage Cutters. Successful bearing mountings have been developed for ensilage cutters of either the flywheel or the rotary type. An example of the former, shown in Fig. 6, gives an idea of how a simple mounting can be adapted to meet the load and other problems involved in operation. The bearing cones are pressed on the shaft and located by spacer sleeves that bear against the hub of the flywheel proper. The cups are fitted into the housing, and the bearing set-up made by means of the closures, which are threaded into the housings. The set-up is locked by means of strips bolted to the housing, and fitting into notches in the closure. Since surrounding atmospheric conditions are not particularly bad, a simple form of closure that will prevent lubrication leakage is perfectly suitable. The mounting developed for rotary cutters, shown in Fig. 7, is similar in its principal characteristics to that already described. One important requirement is taken care of in both types of mountings, namely, the rigid holding of shaft alignment. For ensilage cutters to work most effectively, the clearance between the knives and the cutter plate must be very close. Therefore, the shaft must be held precisely to its original setting throughout operation, or there is liable to be trouble. With the anti-friction bearing mounting the shaft is held very rigidly to setting; how much so can be judged from the fact that it is possible to set the knives, and then back the tractor into the belt without disturbing the adjustment. In addition to these features, there is also a considerable saving in the amount of lubricant used, and the time required to apply it. Plain bearing shafts require lubrication about every hour during operation, while the addition of a small amount of lubricant about once or twice a season usually will keep anti-friction bearing shafts operating perfectly.

Feed Grinders. The load characteristics of feed grinders, whether of the hammer or disk type, are very similar to those encountered in ensilage cutters, with the addition that shock loads are present, their severity depending on the sort of material being ground. There is the same relatively high speed, and the same necessity for preserv-



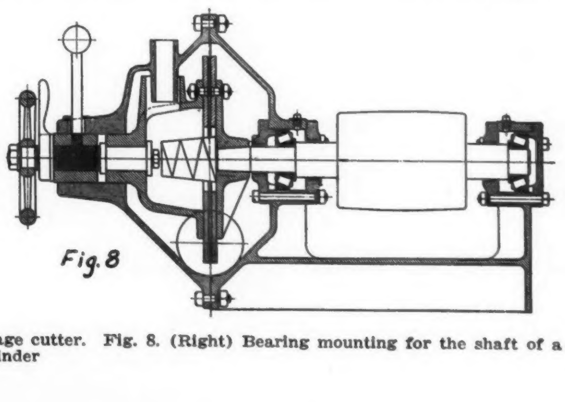
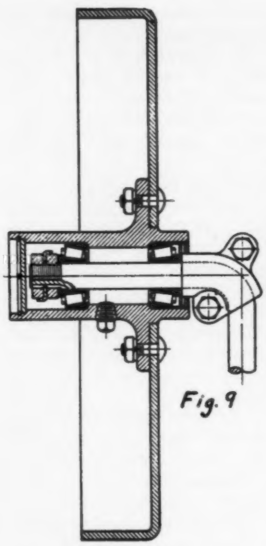
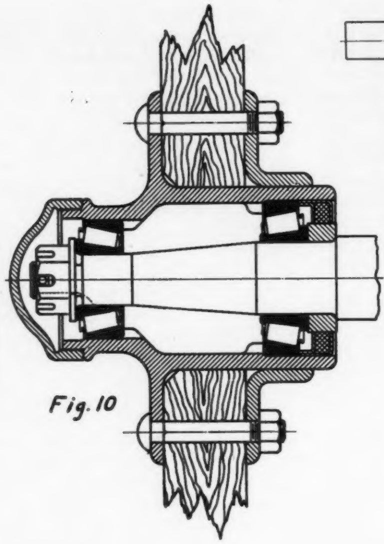


Fig. 7. (Left) Bearing mounting of cutter shaft of a rotary ensilage cutter. Fig. 8. (Right) Bearing mounting for the shaft of a feed grinder





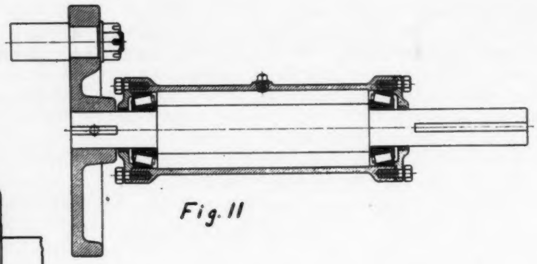


Fig. 9. (Extreme left) A typical bearing mounting for a farm implement wheel. Fig. 10. (Left) Bearing mounting for wagon wheel. Fig. 11. (Above) Bearing mounting for the fan shaft of a direct-stroke windmill

ing clearances between parts. As a consequence, the method of mounting the bearings is much the same, as far as general considerations go. Fig. 8 is a typical mounting for the disk type grinder, which is chiefly notable for its simplicity. The bearing cones are pressed onto the shaft and located by shoulders, while the cups are fitted into the housing. The bearings are set up by shims between the housing and the outer closure. The general advantages in this case are preservation of the original bearing setting and shaft alignment and reduction in the expense and time involved in maintaining proper lubrication.

Wheels. Practically every form of power farm equipment is made mobile by means of wheels of one sort or another, and generally speaking the load characteristics of most wheels are very similar. In fact, barring a few variations in weights and speeds, it might be said that they are common to all cases, irrespective of the type of machine in question. The loads are mainly radial, but there is usually a thrust component that must be taken into consideration. This latter may arise from any one of a number of causes—uneven surfaces traveled over, the natural thrust going around corners, the swaying of the body, to mention a few.

Bearing mountings for this service also have a good many points in common; Fig. 9 is chosen as a fairly typical example. The cups are pressed into the hub usually against locating shoulders, and the cones are given a light fit on the axle. The whole assembly is set up by means of a nut on the end of the axle. It will be observed that there is large space in the interior of the hub that is available for lubricant storage. The mounting for wagon wheels, as shown in Fig. 10, varies somewhat in details, principally because of the greater speeds and rougher usage generally to which wagons are subjected. The basic principles of the mounting are the same. It might be added that in all cases closures have been adopted that are calculated to retain all lubricant, and to prevent the entrance of any foreign matter.

The principal benefit to be expected from the use of anti-friction bearings in wheels is of course the reduction in draft. This may range anywhere from 25 to 30 per cent, or even more. In the case of individual machines, whether they operate under their own motive power or not, the saving in effort required to move them is well worth while. In the case of wagons, in addition to reducing the draft, the use of anti-friction bearings permits carrying heavier loads safely at higher speeds. In any case, the wear and tear on both wheels and axles is greatly reduced, which means that the effective life of the machine, or vehicle as the case may be, is prolonged indefinitely, all other things being equal.

Windmills. In windmills the principal requirement to be met by the bearings is that of continuous service over long periods of time, with a minimum of attention. The principal function of the bearings is the reduction of friction. The loads are not particularly heavy, but both loads and speeds fluctuate wildly. Fig. 11 shows a more or less standardized mounting that has been developed for a direct-stroke mill. Aside from its simplicity the most noteworthy point about it is the size of the space available for lubricant storage. Such ample provision means that infrequent renewals of lubricant are unnecessary, in fact a mill will run for months on the original supply. Another feature of anti-friction bearings that is valuable for this service is their uniform coefficient of friction. The mill sails can be designed for a certain speed at a given wind velocity, or pressure, with the assurance that the results will be permanent during the life of the mill. Furthermore, it has been found that mills on anti-friction bearings will operate when only the lightest summer breezes are moving. The main point is, as has been stated above, that continuous service is assured. Where windmills are used at all, too much depends upon their ability to work under any conditions to permit overlooking any factors that will increase their effectiveness.

In conclusion, it might be said that the examples that have been given are by no means a complete list of the applications that have been made to farm machinery. Nor do they represent all the applications to be found on single machines of any given type. The former would include dust sprayers, potato diggers, manure spreaders, liquid sprayers, mowing machines, and many more. The latter would include crankshafts, gear drives, power take-off shafts, combine leveling devices, and a host of others. Those that have been described have been selected as being either the most typical, or the most important, in their particular classes. It is hoped that this description will, in addition to showing what is being accomplished on the engineering side, give some idea of how the user will benefit from the presence of anti-friction bearings in the equipment upon which he depends so much.

The Design of the Mangum Terrace

By Claude K. Shedd[1]

THE practice of terracing has been advocated in bulletins and by extension workers in some of the corn belt states for many years past; but the result so far has been the adoption of this practice by only a small proportion of farmers who have land subject to erosion. Sufficient time has elapsed since terracing was first advocated in this region that we might expect extensive adoption of the practice if terraces as built had proven to be well adapted to corn belt conditions and farming methods.

It may well be asked then if terracing is really well adapted to corn belt conditions, if terrace design is faulty, or if farmers are not building terraces according to specifications. I have observed enough examples of successful terracing to be firmly convinced that this practice can be adapted to corn belt conditions. It appears, however, that some revision of terrace design may be desirable. It is the purpose of this paper to outline briefly some methods of attacking the problem of terrace design.

The possibility of applying theoretical principles of hydraulics should be considered. The terrace is similar in construction to an irrigation canal passing across the slope of a hill. In building such a canal, the dirt excavated in making the ditch is used to make an embankment on the downhill side of the ditch. The shape of cross-section can be worked out by principles of hydraulics so that the velocity of the water will be kept within permissible limits and the amount of dirt to be moved in construction will be reduced to a minimum.

There are some difficulties in applying these same principles to the design of a terrace. In the case of the irrigation canal the amount of water to be carried is known, but in the case of the terrace the amount of water will vary according to the amount and intensity of rainfall, the crop and state of cultivation of the land, the steepness of the slope and the spacing and length of terraces. Since the quantity of water depends on so many variables and we have little experimental data on which to base estimates of some of these variables, it is doubtful if calculations based on hydraulic theory are of much value in determining the best shape and size of cross-section for a terrace.

There is, however, some use for the principles of hydraulics in terrace design. It is well known that water in a broad, shallow stream will do less scouring than the same quantity of water confined in a narrow channel on the same grade. Therefore, a flat bottom terrace ditch will scour less than a V-shape ditch. The flat bottom ditch is also preferable in that the necessary capacity is obtained without digging so deep and the ditch is easier to cross with implements. With the graders and V-drags commonly used in terrace construction workmen without special instruction will nearly always make a V-shape ditch. Therefore, it is important to specify the shape of ditch desired.

Another point regarding terrace design may be at least partially cleared up by use of a pencil and piece of paper. Instructions for terrace construction commonly show dirt moved in from both sides to build the terrace ridge or embankment. It is evident, however, that a given size and shape of terrace channel is built with the moving of a minimum amount of dirt when the embankment is built entirely with dirt removed in making the ditch. The terrace cross-sections shown in the accompanying sketches are drawn with fill-balancing excavation allowing about 15 per cent expansion in volume. Fig. 1 shows a terrace in which all dirt is moved from the ditch to make the embankment. Fig. 2 shows the same size and shape of channel but built by moving equal quantities of dirt from both sides to build the embankment. The writer has not attempted to compare these two cross-sections by mathematical calculation, but the use of a planimeter on the drawings indicates that about 30 per cent more dirt must be moved to build a terrace as illustrated in Fig. 2.

While theory has a place of some importance in terrace design, still we shall no doubt find it necessary to depend very largely on the "cut-and-try" method. Progress under this method can be greatly accelerated if engineers will do two things: (1) Make specifications as to terrace cross-sections clear, definite and complete; and (2) at every opportunity measure the exact dimensions of cross-sections of terraces that have proven successful and record this information together with grade and spacing of terraces, slope of land, cropping and cultural methods.

Bulletins on terracing now in print do not generally give definite specifications on shape and size of terrace cross-sections. The height of the top of the ridge above the bottom of the channel and the width of base are usually the only two dimensions specified. I have found farmers ready to make use of more exact specifications. One farmer cooperator, on his own initiative, made a template for testing the size and shape of his terrace channels.

Fig. 1 shows a size and shape of cross-section which has been approximated in a number of successful terracing demonstrations in eastern Kansas and Missouri. Some of these terraces have been subjected to rather adverse conditions as to rainfall and cultivation. Fig. 3 shows the same shape of terrace as Fig. 1 but on land having 10 per cent slope. The over-all width is increased from 18 to 23½ feet and the labor of building is greatly increased. To build on a 5 per cent slope as shown in Fig. 1 it is necessary to move about 14 cubic yards of earth per 100 lineal feet

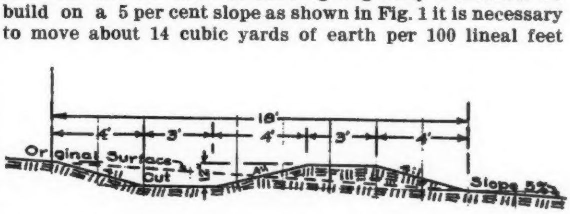


Fig. 1. Cross-section of a terrace for moderate slopes, requiring 14 cubic yards of excavation per 100 lineal feet of terrace

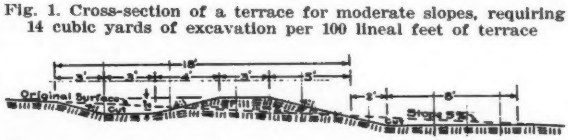


Fig. 2. A ground slope and terrace shaped the same as in Fig. 1, except that dirt is moved from both sides to build the embankment and 18½ cubic yards of excavation are required per 100 lineal feet of terrace

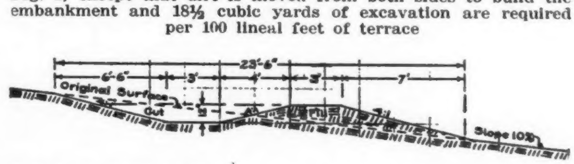


Fig. 3. A channel the same as in Fig. 1, built on a 10 per cent slope, with 23 cubic yards of excavation per 100 lineal feet

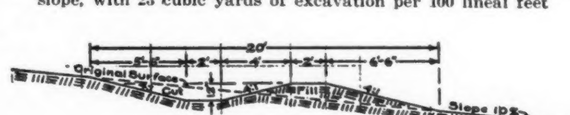


Fig. 4. A terrace of reduced width for steep slopes. It requires considerably less excavation than a terrace of regular width

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A Mangum terrace in the process of building

of terrace, while to build on a 10 per cent slope, as shown in Fig. 3, it is necessary to move about 23 cubic yards of earth per 100 lineal feet.

In order to reduce the labor of construction on steeper slopes, the width of ditch and ridge may be reduced as shown in Fig. 4. Construction of this terrace requires moving about 17 cubic yards of earth per 100 lineal feet of terrace. It has less capacity, is more inconvenient to cross with implements and requires more careful attention to maintenance than one as illustrated in Fig. 3.

If an estimate of cost is desired this work may be estimated at from 5 to 10 cents per cubic yard, according to the condition of the ground and the efficiency of the grading outfit. A cost estimate per acre can hardly be made until after the number of lineal feet of terrace has been determined by survey. Slopes often vary as much as from zero in some parts to 10 per cent in other parts of the same field. If a field has a uniform slope of, say, 5 per cent the lineal feet of terrace per acre can be determined by computation. The latest edition of U.S.D.A. Farmers' Bulletin 1386 recommends a vertical spacing of 3½ feet for terraces on land having a 5 per cent slope. This would require 622 lineal feet of terrace or 87 cubic feet of excavation per acre and would cost from $4.35 to $8.70 per acre. If a vertical spacing of 5 feet is allowed, there will be 435 lineal feet per acre and the cost would be from $3.05 to $6.10 per acre. On land having a uniform slope of 10 per cent the cost, estimated in the same way with 5-foot spacing and terraces as illustrated in Fig. 3, will run from $10.00 to $20.00 per acre.

It may not be advisable in many cases, for the engineer to give the farmer cost estimates in dollars per acre. The farmer will probably not hire the work done anyway. There are, however, some advantages in making such cost estimates when making a study to determine the spacing and the cross-section of terraces to be recommended.

The other features of terrace design are spacing and grade. Spacing has been determined by a sort of rule-of-thumb method which is supposed to place terraces close enough together to avoid excessive sheet erosion between terraces. Some experimental work indicates that there is a good deal of sheet erosion of cultivated land even on very short slopes, which makes it appear doubtful if it is possible to put terraces close enough together to entirely control erosion. Crop rotations including clover have been demonstrated to be effective in reducing sheet erosion. Possibly by depending upon the beneficial effects of proper rotation it will be found possible to increase the space between terraces.

Terrace grades may always be a moot question because of the different purposes for which terraces may be designed. At one extreme are those who want to save all of the soil and all of the rainfall. The answer to this is level terraces. At the other extreme is the idea that whenever water and soil have moved as far as the terrace channel it is no longer practicable to try to retain such run-off on the field. If design is based on this idea, the terrace will be given all the fall possible without causing scouring of the terrace channel, that is, the terrace channel will be self-cleaning. We have no exact data on which such design could be based but we know in a general way that a self-cleaning terrace would have a rather steep grade at its source, and the grade would be gradually reduced toward the outlet.

At one extreme of design then, we have practically all soil and water saved but a large amount of labor for maintenance due to silting of the terrace channel. At the other extreme we have the labor of maintenance practically eliminated but lose some rainfall and some soil from the field.

A majority of engineers who have worked on terracing have advocated a variable grade, the grade being flatter at the source than at the outlet. This is the reverse of grades found in natural stream channels. The argument for it is that the upper parts of the terrace channel are used as a storage reservoir to equalize flow at the outlet. That it will so operate in case of storms of a few minutes duration will be readily admitted, but suppose that the storm lasts long enough to fill the upper part of the channel to capacity and that the peak of intensity of rainfall comes after that time. It is evident that under such a condition the variable grade would have little if any effect on the peak of flow at the outlet. There is the objection to this kind of variable grade that the channel used as storage reservoir tends to fill with silt and require cleaning, so the argument for storage to equalize flow would seem to give room for some difference of opinion.

All rules at present in use for the grade of terraces are in the nature of a compromise between the two extremes explained above and it would seem that they are all entitled to the rule-of-thumb classification. There is nothing against the rules, however, provided they give the desired characteristics to the terrace.

Harvesting Sorghums by Root Cutting and Combining

By John P. Conrad[1] and E. J. Stirniman[2]

DIFFICULTY in storage is encountered in many sorghum-growing sections because the grain does not dry sufficiently. Soil and weather conditions keep the plants green and growing, and frost is not early enough to check growth and dry the stalks. A satisfactory and economical method of cutting the roots and then harvesting with a combine has been worked out at the experimental fields at Davis, California, and on farms in several sections of the state.

To insure adequate moisture and to allow space for the root cutting machine, wider spacing between rows was allowed in planting. For root cutting the tall varieties, 4 to 6 feet in height, every other space between rows was widened. Varieties of erect-growing sorghum may be planted in rows 3½ and 6 feet apart, if a small tractor is used. The ordinary two-row corn planter may be used by lengthening the bar which carries the marker for the next row a sufficient length to bring it to the center of the two rows planted together; that is, if the rows are to be 3½ feet and 6½ feet apart, respectively, the marker bar should be long enough to make a mark exactly 10 feet from the center of the planter.

In the root cutting experiments at Davis two general types of blades were used. One was a straight blade supported on either side by an upright, making a U-shaped attachment for sled or cultivator. This blade worked most successfully when the blade was inclined to give a suction of about 1 inch in 4 inches. In soil that tends to come up in clods it is necessary that the front parts of the uprights where they go into the soil be sharpened and that the cutting edges of the uprights should be closer together at the front than at the rear so that clods cut off may have clearance by the blades. The U-shaped blades were prone to clog in weedy ground or clog on the sorghum plants themselves when the blade did not register with the row.

The other blade was a sloping one fastened at the end and inclined at a 45-degree angle with the line of draft, one end being unsupported. In actual use with the sloping blade two blades are necessary, one right-hand and one left-hand, to equalize or balance the sidedraft in cutting. Each blade was approximately 27 inches long giving a cutting of approximately 18 inches. The horizontal part of the blade was tipped down at an angle of 15 degrees (or a slope of 1 inch to 4 inches in width of blade). The fin on the outer end of the blade was put on to cut any side roots which would otherwise keep the plant green by supplying moisture from the deeper layers of soil. The sloping blade if given a 45-degree angle will clog very little ordinarily. It is much superior to the straight blade from this point of view. Under weedy conditions in loose soil this blade will clog some. A cutting coulter mounted in front of the shank of the blade materially helps to prevent this condition.

Sloping blades made of 5/16x4-inch plow steel as described above were able to withstand a drawbar pull of 750 to 900 pounds per blade or a total for both of the blades of 1500 to 1800 pounds. In tests where drier, heavier soils were encountered, these blades were bent out of shape when the drawbar pull for both blades went up to 2600 pounds. For heavier work, heavier blades were constructed. To economize on material, a piece of ⅜x14x40-inch plow steel was cut diagonally and then the bends made. This gave width where the horizontal part of the blade fitted onto the vertical, and a narrow outer end. These bladess withstood a total drawbar pull of 3000 pounds without bending and undoubtedly would have withstood much more.

The blades were tried on a number of different carriages and sleds. The U-blade was adapted to a single-row cultivator which was quite satisfactory in cutting a single row in soft or mellow ground. However, this carriage did not have sufficient weight or strength to stand up in cutting on hard, dry ground.

In the experiments much the greatest accuracy of cutting was secured by attaching the two sloping blades on the outside of the runners (4x6-inch timbers, 8 feet long) of a heavy sled. The sled was chained to a tractor orchard cultivator equipped with a traction lift, in such a way that the blades could be pulled out of the ground at the ends of the rows. Adjustments were made also so that by manipulation of the levers practically all of the weight of the cultivator could be put upon the sled.

The kind and size of the power unit for root cutting is determined by the height of the crop, spacing of rows, and draft requirement. Teams can be used most conveniently in close spacing and tall varieties of grain sorghums.

A general-purpose tractor having a clearance of approxi-

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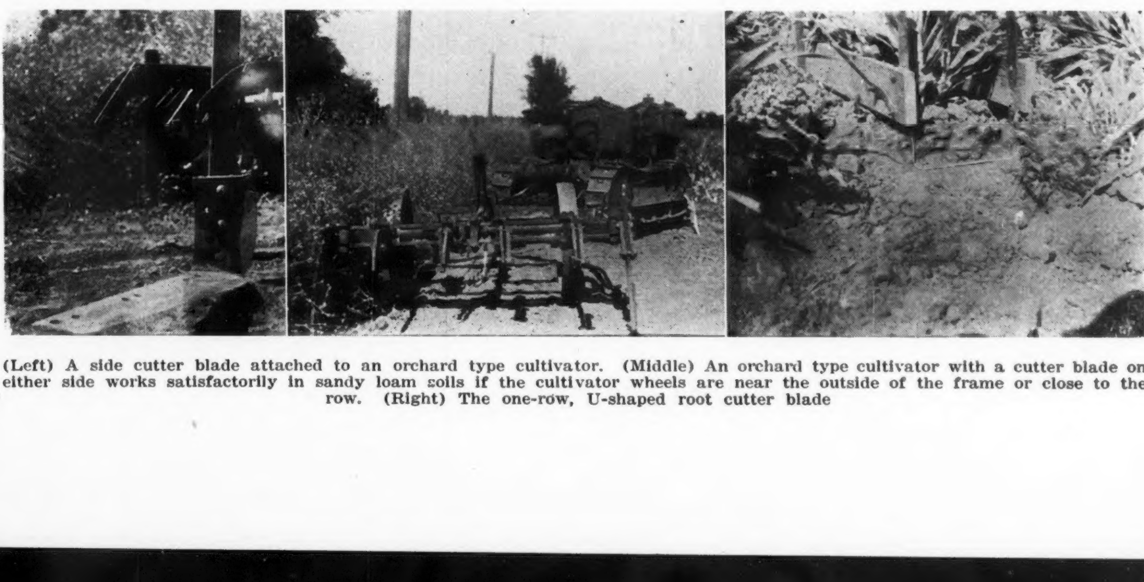
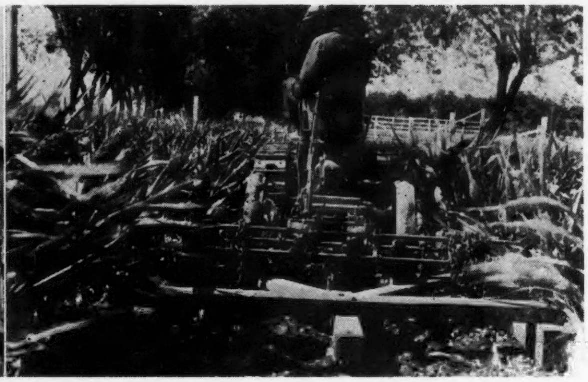


(Left) A side cutter blade attached to an orchard type cultivator. (Middle) An orchard type cultivator with a cutter blade on either side works satisfactorily in sandy loam soils if the cultivator wheels are near the outside of the frame or close to the row. (Right) The one-row, U-shaped root cutter blade

(Left) A general-purpose tractor operating a two-row cutter in dwarf Milo. (Right) The two-row sled-type root cutter with cultivator chassis used for carriage

mately 26 inches was found convenient for cutting one or two rows of the double dwarf varieties with rows 40 inches apart, where the draft requirement exceeded that of a two or four-horse team. When the ground is quite dry a speed in excess of 2 to 2½ miles per hour may have a tendency to push clods and tip over the cut plants. For the larger power units the 3½ and 7-foot spacing is desirable for either short or tall varieties. The wide space, 7 feet, affords ample room for the tractor to travel, cutting the row on either side.

Soil Conditions and Root Cutting. Types and conditions of soil affect the drawbar pull materially. The tests in 1927 were conducted on Yolo silt loam where the crop was grown without irrigation. Here the average drawbar pull was 2600 pounds for the sled equipped with the two sloping blades. The pull varied from 2200 to 3000 pounds.

Tests on a few farms where root cutting was tried during 1927 show a range in drawbar pull from 350 pounds for a U-shaped straight blade cutting one row with a horse-drawn cultivator in a friable, fine sandy loam, to 4500 pounds for sloping blades cutting two rows on rather compact clay loam.

Evidently the type of soil has some relation to the depth at which cutting must be done in order that the plant shall remain upright. Where plants were cut but 5 inches deep on dry, fine, sandy loam, the soil had a tendency to fall away from the roots and let some plants tip over. Many more tipped over in that part of the field where the cutting had been but 4 inches deep. By increasing the depth of cutting to 7 inches no tipping over resulted. It is possible with lighter soil than this fine sandy loam that still deeper cutting might be necessary.

Costs of Root Cutting. With equipment ordinarily found on a farm, the cost of extra equipment, labor, and adjustment should not run over $20.00 to $25.00 for each cutter constructed. Some farmers were able to equip themselves for less than half the latter amount per cutter. From a standard custom rates for tractors and horses the rate for medium to large fields where the equipment is adjusted to the work and no rocks, stumps or hidden tree roots are encountered, should range from 75 cents to $1.50 per acre.

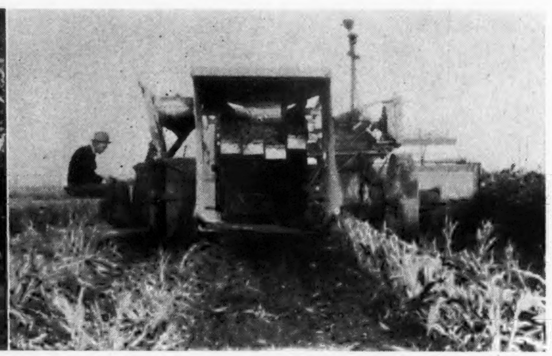
In fields where care was not exercised in root cutting and manipulating the combine harvester header the uncut and lost heads varied from 4 to 5 per cent of the yield.

Two combine harvesting tests conducted in October just ten days after root cutting gave results as follows:

Yield per acre ....2250 and 2060 lb.
Dockage ....1.5 and 2.9 per cent
Cracked grain ....5.25 and 5.45 per cent
Cracked grain in screenings .....0.30 per cent
Moisture content ....13.5 and 14 per cent
Grain in straw (loss).... 0.35 and 0.37 per cent
Heads left in field ....0.5 and 1.3 per cent
Heads cut and lost ....1.1 and 1.8 per cent

Rate of Drying of Grain Sorghums

Variety and Method of Harvest	Date of Harvest	Percentage of moisture on an air-dry basis					
		Before harvest	Sept. 28	Sept. 30	Oct. 2	Oct. 5	Oct. 7
White Yolo							
Root cut	Sept. 27	45.0	19.5	17.0		8.9	8.8
Heads cut and piled	Sept. 27	45.0	26.5	13.1	7.8	7.2	5.1
Bound	Sept. 27	45.0	24.5	16.0	8.8	8.8	

(Left) A field after root cutting. (Right) Combining root-cut grain sorghum

Tractor Uses 1250 Heat-Treated Parts

By H. Grothe[1]

FOR three hundred days a year with double ten-hour shifts—6000 hours a year—are tractors used on Hawaiian pineapple plantations.

In the Imperial Valley just over the Mexican border, the Colorado River Land Company reports that their tractors each plow 10,000 acres yearly; in plowing they work 23½ hours daily. In fact, the 5000-hours-per-year tractor is becoming common.

A few years ago such service from tractors would have been impossible. Wear caused by gritty dust, grinding mud, water and snow would have worn out some vital engine part. Today such wear is largely eliminated by heat-treating wearing parts and using of oil filters and air cleaners; the Caterpillar Tractor Company believes that heat-treating of parts is really the most important step toward longer tractor life.

It should be understood that heat-treating is much more than a mere hardening or tempering process. It is desirable to have some material soft throughout, some soft inside and hard on the surface, and some tough rather than hard. Various methods are used according to the qualities which must be possessed by the finished piece.

Opposite heat-treatments will give very different qualities to the same or similar material. The head of a cold chisel is made tough but not brittle, so it will gradually flatten under hammer blows, instead of breaking, while the point is tempered hard to penetrate the material which is being worked upon. An example in the manufacture of our tractors is the difference in treatment given the track roller shaft and the sprocket shaft of one model.

The track roller shaft is heat-treated to give an extremely hard outer surface and yet to retain a soft, tough core. This part is made of low carbon steel. After carburizing and a second operation of heating and quenching, the hardness of the "case" or outside is considerably increased. The shaft is then hard where the wear comes, while the core is comparatively soft but very tough and shock resistant, because this part carries the weight of the tractor and is subject to both wear and impact.

In contrast to this heat treatment is that given the sprocket shaft. This shaft is high carbon alloy steel. It does not have to be hard and wear resistant so much as tough and distortion resistant, so it is heat-treated accordingly.

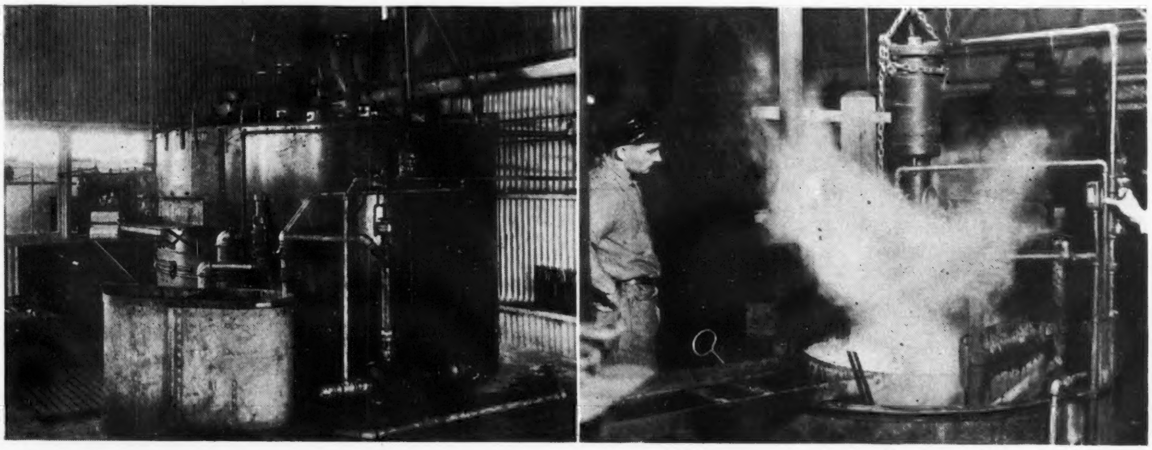
Another example of opposite qualities obtained by different heat-treatments may be found in the steel castings used for the sprocket and seat bracket of another model. The original material is the same, a steel casting. The seat bracket must be absolutely safe against breakage, but requires comparatively little rigidity or wearing quality, so it is annealed for toughness. It will bend rather than break. In the case of the sprocket, strength and resistance to wear and distortion are necessary. If strained out of alignment, it must spring back into place the instant the strain is removed.

It is easy to be deceived as to the relationship of hardness and wearing qualities. A file test is only a surface test. A 3½ per cent nickled steel oil-hardened gear is fileable, but will wear longer and be stronger than other and cheaper materials that cannot be filed. The term "glass hard" is often spoken of as a desirable quality. In general we try to avoid it. Many parts could be made glass hard without any difficulty and with cheaper methods and material than now. They would be hard, but not shock resistant.

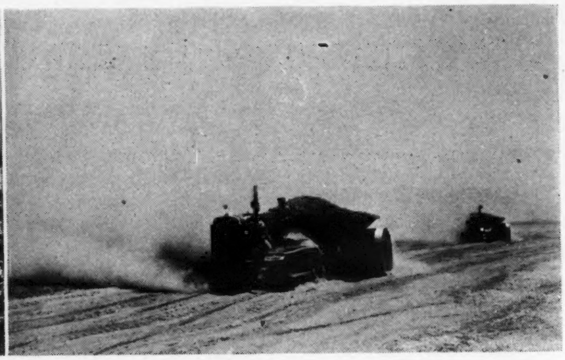
Materials Used. The metallic parts of our tractors are for the most part either castings or forgings. With the exception of a few small parts such as brass radiator tubes and bronze and babbitt bearings, all metal used is either iron or steel. Iron is used almost entirely in the form of castings. It is never drop forged. Steel may be used either as bar stock or in castings or forgings and may be either low carbon or high carbon, plain or alloy—usually but not always heat-treated.

A casting is made by pouring molten metal into a mold of the proper shape, in which the metal hardens. Unless heat-treated afterwards, an iron or steel casting is quite brittle and will stand comparatively little shock or bending strain. In the case of such parts as the crank and transmission cases, cast iron is used as rigidity is the chief requirement. In the case of the sprocket, considerable strength and wear resistance are necessary, requiring the use of a steel casting, which is heat-treated to develop these characteristics to their maximum.

[1]Engineer in charge of steel treating, Caterpillar Tractor Company.



Two views of the heat-treating equipment in the San Leandro plant of the Caterpillar Tractor Company. At the left is a 110-inch rotary electric furnace with single-tank quenching system, which uses water direct from the pump to the quenching fixture. At the right is shown the operating of quenching final drive sprockets



These two views show extreme conditions tractors have to meet which has necessitated the extensive use of heat-treating of working parts

A forging will have much higher resistance to shock than will a casting. In making a forging the metal at high heat is hammered into the desired shape. In making a drop forging a very heavy hammer is used. In the head of the hammer and on the anvil are dies in which are cut the shape of the piece to be made. Under the pressure of successive blows of the hammer the hot metal gradually flows into the dies and assumes the required shape. At the same time there is a change in structure and an increase in the density and therefore in the strength of the metal. Forgings are subsequently heat-treated to take out any internal strains which may have developed in the making, and to bring out fully their properties of strength and wear resistance. The fact that a piece of steel is drop forged is an indication that it is good metal, as only good material will take shape satisfactorily under a drop hammer.

Heat-Treatment Processes. In choosing any material, or the heat-treatment thereof, the first consideration is the function of the part, what load it must carry, and to what shocks and strains it may be subjected. On one hand resistance to penetration or abrasion, strength or stiffness, and elasticity must be considered. Opposed to these qualities are ductility, toughness and resistance to shock. That is, increasing the strength reduces the ductility, and so on. Our choice is that which will give the best all-around results in the service to which the part is to be put.

The following heat-treating processes are the most important of those which effect the structural and physical characteristics of materials used in the construction of our tractors:

Annealing and normalizing have a softening effect. They give ductility (so that the metal can be more easily deformed), give uniformity of structure, relieve strains and distortions, improve machinability and allow more nearly uniform results in later heat-treatments. There is no sharp line of distinction between these processes, the main difference being the rate of cooling.

Quenching, usually in water or oil, has the opposite effect of hardening the metal. At the same time it refines the grain. It gives strength and wear resistance, but with a tendency toward brittleness and internal strains which usually make necessary further heat-treatments.

Drawing again softens the steel, but the degree of softening is under control so it is a toughening process. It is only used after a quench. The material is reheated to a moderate degree to give resistance to fatigue, shock and vibration.

High carbon steel contains sufficient carbon so that it will harden when heated to the proper temperature and quenched.

To satisfactorily harden low carbon steel an additional percentage of carbon must be incorporatated in and near the surface of the steel. This is usually accomplished by either carburizing or cyaniding. Carburizing or casehardening is designed to harden the outer area of the metal to resist extreme wear, while leaving the inner core soft and tough to resist shocks. The steel is packed in boxes with a mixture of charcoal and certain chemicals, which combination at high heat produces a gas composed of carbon and oxygen. The carbon of this gas is absorbed and taken into chemical combination by the steel, thus producing a thin case which is of higher carbon content than the core and which varies according to the duration and temperature of the heating. The material is allowed to cool in the pack, after which it is reheated and quenched, which gives it a very hard surface with a soft, tough core.

In the cyaniding method hardening is obtained by heating the part to be treated in a molten solution of sodium or potassium cyanide and quenching directly in water. This process is satisfactory for small parts such as nuts. The penetration is only about 0.005 to 0.010 inch. Great depth is not required, hardness being desired merely so that the corners of nuts will not give way under the wrench, and in the case of other parts so that the resistance of the part to slight surface wear will be increased.

Inspection. The quality of our tractors is guaranteed by maintaining a close check on both chemical and physical properties of all materials used. All material is purchased to chemical and physical specifications, subject to checking at the factory, and is under accurate control and supervision at all times. This statement is to be emphasized, as the heat-treating of unknown metal leads to uncertain results and to failures in the field.

The physical characteristics are checked both before and after the various heat-treating processes by means of Universal testing machines, impact testing machines, and Brinell, Rockwell, and Shore hardness testers. The steel is also subjected to microscopic examination, both as it comes from the mill and after forging.

In making a high grade tractor there are three essentials with respect to accuracy. Close limits must be set on the variation from exact size which is permissable for each machining operation. This variation is frequently held down to 0.0005 inch. Accurate instruments and gages must be maintained for the measurement of such limits. (The Johannsen gages, used as a final check on the other, will readily show a variation of 0.0001 inch.) Finally, the standards set must be enforced by a most rigid inspection of finished parts.

Successs in this direction has made possible the 5000-hours-per-year tractors. Tractors working 2000 hours a year are common. A few years ago 400 hours was thought to be a good year's run. That heat-treating is largely responsible for these added hours is proved by the fact that the Caterpillar Tractor Company now heat-treats approximately 1250 parts per tractor whereas a few years ago it heat-treated but a few parts such as gears and track pins.

Harvesting Corn With a Combine

By E. G. McKibben[1]

DURING the last week of December 1928 the department of agricultural engineering at Iowa State College harvested 2.3 acres of corn with a 10-foot combine. While the results of this trial were somewhat unsatisfactory, they served to define more clearly the problems involved and the possibilities and limitations of similar methods of harvesting corn.

Before these results are presented it is only fair to state that several instances of the rather successful use of slightly modified small grain combine harvester-threshers for harvesting corn have been reported from Kansas and Nebraska. In drawing his conclusions the reader should also keep in mind the following facts:

1. It was the first attempt in the locality and by the operators to harvest corn by this method
2. Many of the conditions described here were unfavorable
3. The machine used was designed for small grain and was in no way intended by the manufacturer for combining corn.

Conditions. The corn was a strain of Reid's yellow dent which had been drilled in rows with an 18-inch spacing. It had grown to medium height but had gone down badly, due to weather conditions and the lateness of the season. One-third to one-half of the ears were touching the ground. The ears averaged about 5.5 ounces in weight, a little over 6 inches in length, and about 5.5 inches in circumference. The total yield was only about 21 bushels per acre. Delay in harvesting was caused by the unusually stormy weather and the use of the combine in soybean harvesting at another location. The low temperature (between 10 and 20 degrees Fahrenheit, the small area, and a desire to finish as soon as possible (before snow entirely prevented the work), all tended to reduce the efficiency of this study.

Adjustmnts. Because of the conditions stated above there were not as many adjustments tried as there should have been. Three of the reel slats were removed and the arms carrying the other three slats were lengthened. Also the spaces between the reel arms, slats, and shaft were covered with one-half-inch hardware cloth in order to prevent the corn stalks from wrapping on the reel slats. Even with these changes it was evident that a reel was an unsatisfactory gathering device. It knocked off too many ears and did not force the stalks onto the header platform in a satisfactory manner.

[1]Associate professor of agricultural engineering, Iowa State College. Mem. A.S.A.E.

The pea vine guard type of cutter bar was used and gave complete satisfaction.

The cylinder was operated at grain harvesting speed, between 900 and 1000 r.p.m., although we learned later that we would probably have had better success with a speed similar to that used in threshing soybeans, or about 500 r.p.m. Best results were obtained with one row of concave teeth.

A piece of one-half-inch mesh hardware cloth was placed over the adjustable lip sieves which were used in both the shoe and the recleaner. This cloth was fastened only at the upper edge. All fans were run with wide open air shutters, giving the maximum amount of air.

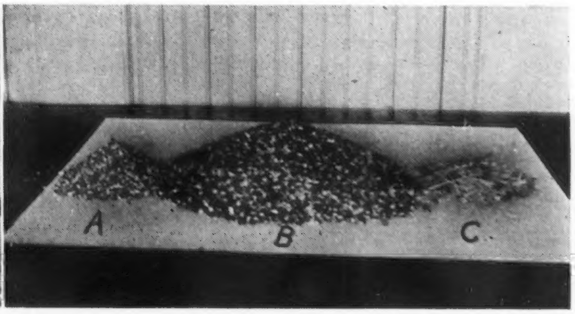
Results. As previously stated the results were not very satisfactory. However, the reader should keep in mind the adverse conditions mentioned, and also the fact that it was the operator's first attempt to harvest corn by this method.

As has so far always been the case with corn harvesting machines, one of the great difficulties was getting the corn into the machine. About 50 per cent of the corn was left in the field, and the feed to the cylinder of the stalks and those ears which were harvested was very irregular. In order to keep from choking the machine frequently, it was necessary to drive about one mile per hour and to cut only two rows.

There was considerable trouble with ears getting between the header platform and the header draper, thus stopping the draper. This condition also caused excessive wear on the chain driving the draper. There was also much time lost because of clogging in the feeder house. The accompanying table shows the number of times it was necessary to stop because of these difficulties during the last nine of the thirteen rounds made during the trial.

Table Showing Number of Stops From Three Different Causes

	Number of Stops Caused by		
Round number	Draper trouble	Feed house clogging	Divider board
5	3	2	
6	9	4	
7	4	5	
8	4	4	
9	7	3	
10	2	2	2
11	10	4	2
12	8	3	1
13	5	4	



(Left) The modified combine in operation in the corn field. (Right) Material taken from the grain bin and separated by hand. A is the pile of cracked kernels; B, the whole kernels, and C, the pieces of stalks and leaf ribs

Once the corn started through the machine the threshing operation was rather satisfactorily performed. The cracking of kernels was not excessive, and the kernels were practically all removed from the cobs.

There seemed to be no difficulty in separating the corn from the larger mass of shredded stalks. However, with the equipment being used in the recleaner (adjustable lip sieve) we were unable to separate small pieces of broken stalks and leaf ribs from the shelled corn. One of the accompanying illustrations gives a relative indication of the amount of cracked corn and broken stalks in the shelled corn. Part of this difficulty was due to the high percentage of moisture in these pieces of broken stalk. The moisture content of the shelled corn was 18.4 per cent and of the broken stalks, 22.6 per cent. It is generally agreed that this is too high a moisture content for successful storage in bulk without special provision for drying.

Problems. The results of this trial seem to indicate that the following problems must be solved before a direct shelled corn method of harvesting can be successfully used:

1. A satisfactory gathering and feeding device must be developed. Probably the greatest fault of even the conventional type of picker is the fact that it leaves too many ears in the field.
2. Either the moisture content of the corn must be lower at time of harvest or special provision must be made for drying immediately after harvest.
3. A satisfactory device for separating small pieces of broken stalks from the shelled corn must be developed. (This is probably the least difficult and in fact may already be solved.)

Some Possible Solutions. As is the case in the solution of all our field machine problems, there are three fundamental lines of attack, any one or all three of which may be used:

1. The crop may be changed as a result of applied genetics to one more suited to direct harvesting methods.
2. Methods of management may be changed, that is, methods of planting, cultivating, and harvesting. For example, some modification of the windrow and pickup system now used in small grain might be developed.
3. Modified forms of old machines or new machines may be developed.

In any event it must be admitted that the application of power to the corn harvesting problem has lagged far behind other power farming developments. For example, the advantage of our best corn harvesting machines over hand picking is small when compared with the advantage of a two-row corn plow over a hoe.

Chemistry a Great Aid to Agriculture

THE United States now has a higher industrial utilization of agricultural raw products than has any other nation, although in the past the nation has been widely criticized for wasting both natural resources and its agricultural materials, said Dr. Henry G. Knight recently in an address on the agricultural problem and the role of chemists in dealing with it, delivered before the Institute of Chemistry of the American Chemical Society at Evanston, Ill. "In spite of this comparative advantage," said Dr. Knight, who is chief of the Bureau of Chemistry and Soils of the U. S. Department of Agriculture, "we should not be satisfied with results," and he looked to cooperative developments in agriculture to open the way to more effective use of by-products.

The present depressed condition of agriculture is worldwide. It is stated with surprising frequency that the solution of the present agricultural situation lies in the preservation of a proper balance between farming and industry. The desirability of this is recognized by the leaders of industry as well as by those primarily interested in developing a better situation for agriculture.

The reverse of cooperation is illustrated by numerous industries which have entered the agricultural field to insure themselves an adequate and dependable supply of raw material—for example, a chocolate manufacturer who operates both dairy farms and cane plantations; rubber companies producing cotton for tire fabrics and operating rubber plantations; sugar refineries have acquired sugar plantations; a large woodpulp corporation having an excess of hydrogen as a by-product is now farming Florida tracts to supply cheap peanut oil for hydrogenation; and a Louisiana company making fiber products is growing sugar cane to insure a bagasse supply with sugar as a by-product.

Industrial utilization of agricultural surpluses and wastes, as a means of promoting closer affiliation between farming and manufacturing, has been suggested as a remedy. It has been under consideration in various ways for more than a century and with varying success. Alcohol is an example, which can be manufactured from such farm wastes as grain, potatoes, sorghum, fruit, cannery waste, cornstalks, etc., but in actual practice small plants can not compete economically with large well-equipped factories.

Plans were at one time made for using the bagasse from sugar cane in the manufacture of paper and filter board. Considerable capital was invested. But nothing came until a large company worked out practical economies in production.

Straw is one of the largest waste products on farms. Theoretically and technologically it may be worked into carbon, straw tar, illuminating gas, acetic acid, methanol, and other products by one set of methods; by various methods of hydrolosis it is possible to make xylose, furfural, oxalyic acid, paper, strawboard. As a practical matter the conversion of these wastes will depend on comparison of values.

What is needed in cases of this kind is a careful determination of the value of straw for each of its different uses under different conditions of climate, location, commercial development. What is the value of straw as a fuel, as a fodder, etc? Is it more profitable under certain conditions for the producer to use it for enriching soil or to sell it for industrial purposes? The answer to these and other questions of vital importance which influence decision as to the use to which agricultural surplus or residue are to be put, are not arrived at without exact and searching information leading to a knowledge of economic values. To obtain such information requires the services of men of judgment who are versed in agriculture, chemistry and business management. Without such information, the choice of a method for industrial utilization may be more or less of a gamble.

Commenting on Dr. Robert Stewart's theory that "when capital is available in sufficient quantity and able management can be obtained the rewards of farming are comparable with those obtained in other manufacturing lines," Dr. Knight said that, when the farmers of a section unite in large cooperative enterprises, capital and talent for efficient management are attracted to help them in the solution of problems, as has been shown again and again. Under such conditions the more efficient utilization of the products of the farm, through the aid of chemistry, may be expanded.

Special Applications of the Oxyacetylene Welding Process to the Repair of Farm Implement Parts

By J. I. Banash[1]

FARMERS have lost many thousands of dollars by having to scrap broken implement parts and replace them with new ones. This costly practice was made doubly expensive by the delays which usually followed while new parts were being delivered. These unfortunate situations of course usually occurred during the height of planting or harvesting, and the time lost was often a greater item of expense than the entire cost of a new machine. A delay of a week or ten days, for instance, in securing a binder part, when wheat is dead ripe, can easily mean a serious loss to the crop.

Job welding shops and experienced welders are now to be found in most rural communities and they have saved the farmer many dollars in time and new parts. Typical examples of these savings on the farm are to be found in the welding of such farm equipment as separators, manure spreaders, clover hullers, wagons, road scrapers, hay rakes, binders, threshing machines, corn planters and side-delivery rakes. The cast iron wheels of these implements usually have steel spokes and rims which are set in a heavy cast iron hub. These spokes often work loose at the hub or snap off entirely. Both conditions are jobs for the welder.

The manure spreader wheel shown in the accompanying illustration had two broken and nine loose spokes. The two broken spokes were welded first. To do this it was necessary to melt the cast iron which encloses the small end of the steel spokes, scraping the cast iron out with the welding rod. A large tip was used for the melting. When enough of the steel spoke was exposed so that it could be welded, the correct tip for welding steel of this thickness was attached to the blowpipe and the regulators adjusted to correct pressures, conforming to the manufacturer's chart. The spoke was then lined up and the brick chamfered in a double V with the blowpipe. Using a ⅛-inch steel welding rod, each side of the steel spoke was welded and the part at the joint was built up a little to serve as an added "grip."

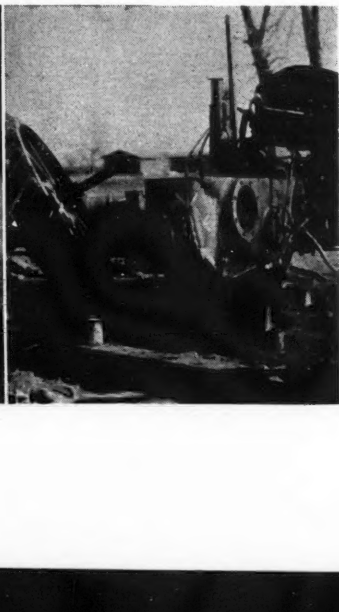
After the steel spoke had been welded, it was necessary to build up the cast iron hub again, using a good grade of cast iron welding rod and cast iron flux. From time to time this flux was added to float the impurities out of the weld. Care had to be taken to secure complete fusion with the adjacent metal of both hub and spoke. The iron was built up around the steel "grip" of the spoke which gave the added strength of a socket joint to the inherent strength of the weld. The hub was then built up around the spoke, a little higher than the circumference of the hub, forming a collar. If some additional spokes needed tightening, the cast iron around the spoke was melted down and scraped out with the rod. New cast iron was then added and the weld built up, fusion being secured with the steel spoke, around which a collar was formed to finish the weld.

Occasionally the job welder in a rural community has a chance to exercise his ingenuity and some very clever ideas are worked out. For instance, there is a certain Western welding shop proprietor who specializes in "skeletonizing" tractor wheels. With the blowpipe he cuts away that portion of the wheel between the lugs. The remodeled wheels do not leave broad solid tracks, nor does damp soil collect on the wheels between the lugs until the entire space has been filled in. Formerly, the packed soil clinging to the wheels added dead weight to the tractor and caused loss of hauling power since much of the ground-gripping value of the wheel was lost.

Although considerable metal is cut away it was found that the wheels were not weakened. The entire operation required about 45 minutes, about 45 cubic feet of oxygen and about 15 cubic feet of acetylene. When new clean wheels are brought to the shop, this welder makes a flat charge per wheel, but when they require extensive cleaning, or when it is necessary to make the trip to the farm to do the cutting, he charges on an hourly basis.

Another progressive job welding establishment ever on the alert for new applications has built up a fine trade in hard surfacing plow shares and disks with a special material known as "Stellite." This concern is situated in the Southwest, in the middle of an extensive cotton and grain-growing district, where the soil is rather abrasive and consequently plow shares and disks wear out rapidly. The time necessary to change these parts, and the subsequent delay while waiting for old shares and disks to be repaired and resharpened by the blacksmith, was proving a costly delay. The successful application of a layer of stellite to the shares and disks of one large operator convinced other farmers in the district that the practice was a real time and money saver. Previously, the particular farmer mentioned had been getting about one and one-half rounds from new shares and disks on a section of land of about six lineal miles before he was obliged to send them to the blacksmith for new points and resharpening. The stellited shares plowed three sections, 1920 acres, and were still in good condition at the completion of the work. Actual plowing tests have shown additional length of

[1]Consulting engineer, Chicago. Mem. A.S.A.E.



(Left) This manure spreader wheel, with two broken and nine loose spokes, was repaired by means of the oxyacetylene welding process. (Right) This tractor was put out of commission by the breaking of the differential housing. A new housing would have cost $150; it was repaired by bronze welding at a small fraction of that cost

service obtained by stelliting plow shares to be in the ratio of 4.8 to 1.

The method of application determines the efficiency of the stellited shares. The stellite is applied on both top and bottom of the point, but on the bottom only of the blade of the share. The reason for this is that stellite, being so resistant to abrasion, the top wears off first and the sharp stellite edge on the bottom side of the blade has a tendency to dig in instead of trying to ride out of the ground. This permits the share to be held in the ground with the least amount of effort.

The stellite is applied by the oxyacetylene welding process and should not be over 1/16 inch thick by ½ inch to ⅝ inch wide on the blade. A thicker application seems to spoil the efficiency of the share and is only a waste of material. This applies to the blade of the share only. The top and bottom of the actual point are stellited as wide as conditions require.

The application can no doubt be successfully and profitably used in most farming districts and is another good argument why all local machinery maintenance shops should have welding outfits.

Bronze welding is another phase of the oxyacetylene process which in a special way fits a long felt need of the farmer. Formerly broken cast iron parts of large and intricate design presented a welding problem which required much thought; indeed it was hard to find a welder who would confidently tackle the job. Today these difficulties are largely overcome by bronze welding.

A tractor used on a ranch in Arizona was put out of commission by a broken cast iron differential housing. A new casting would cost $150, and could only be procured from the factory which was over a thousand miles distant.

First thought suggested dismantling the machine and preheating the broken parts. An oxyacetylene service operator was called in and after examining the break said that dismantling would be unnecessary and that the tractor would be repaired where it stood by bronze welding.

The break was in the form of an irregular hole about 6 inches wide and 12 inches long, with thirteen short cross cracks. The cast iron section was about ⅝ inch thick but no great amount of strength was required in the part; the housing merely had to be oiltight. After cleaning the housing thoroughly, work was begun by arranging the broken parts in their proper sequence. The cross cracks were welded first, starting at the end and working toward the main opening. When all the short cracks had been finished, sufficient heat had penetrated through the casting from the topmost crack to the top of the casting (a distance of about 12 inches), so that the metal was hot enough and had expanded enough to take care of the temperature stresses after the long welds were completed.

The technique of bronze welding is not difficult. Its great value lies in the fact that preheating is practically eliminated due to the low melting point of bronze and the fact that the cast iron proper barely reaches a dull red under the blowpipe before the work is completely finished.

The job was accomplished in less than three-quarters of an hour and was made at a very trifling cost, considering the expense of a new casting and the subsequent delay while the new part was being shipped from the factory.

The foregoing examples are but a few of the many ways in which many farmers have been benefitted by the oxyacetylene welding process. They have found the oxyacetylene welder an indispensable aid in machinery maintenance and are quick to consult him when metal parts break or need other repairing.

A Corn Borer Control Device

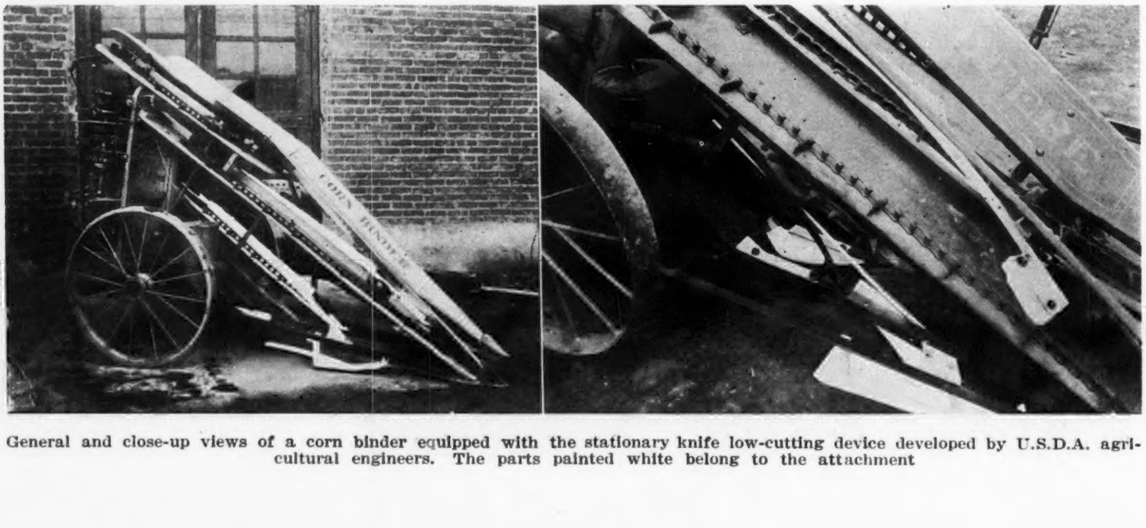
By R. B. Gray[1]

THE most effective means of controlling the European corn borer at the present time is by the aid of machinery. As many conditions are encountered, due to differences in farm practices and varied methods of handling the corn crop, different types of machines or attachments are required.

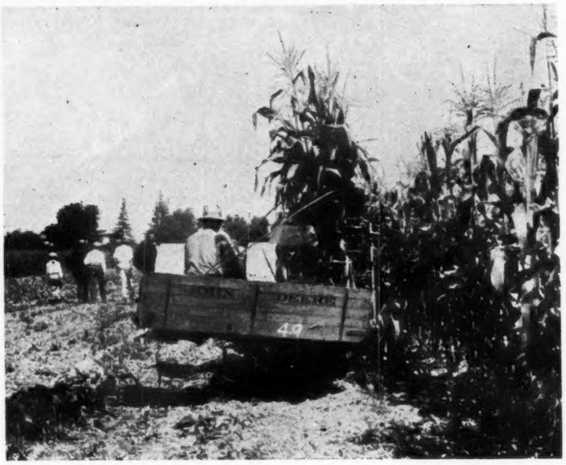
Cutting corn with the standard corn binder leaves stubble 4 or 5 inches high. In badly infested fields a dangerous number of borers are left in this stubble. To facilitate removing practically all of the borers from the field a low-cutting attachment for the corn binder was devised and successfully demonstrated during the fall of 1928 by the agricultural engineers of the U. S. Department of Agriculture, at Toledo.

This device, which has been developed for four of the prominent makes of binders, consists essentially of a long stationary knife set a short distance ahead of and 6 inches lower than the regular reciprocating knife, a special reciprocating knife shield, extension butt gatherer chains and extra throat springs. The knife, made of 3

[1]Senior agricultural engineer, division of agricultural engineering, U. S. Department of Agricultural. Mem. A.S.A.E.



General and close-up views of a corn binder equipped with the stationary knife low-cutting device developed by U.S.D.A. agricultural engineers. The parts painted white belong to the attachment



Work done by the low-cutting device. The rows behind the binder show no stubble. Several rows of stubble as left by the binder without a low-cutting device can be seen at the left

3x5-16x28-inch spring steel, is attached at the right and forward end to the right gatherer angle by means of a combination bracket and weed guard. On the front side the knife is drawn out to a cutting edge with the bevel underneath. The shield, which is fitted into the binder throat and slopes upward over the reciprocating knife, is so shaped as to leave a narrow passage along the right gatherer angle to the reciprocating knife. To accommodate this shield the side knives are partly cut away.

As the binder moves forward the stationary knife, with a slightly curved cutting edge set at an angle of about 35 degrees with the direction of travel, shaves the stalks off at ground level. The extension butt gatherer chains grasp the stalks as soon as they are cut by the stationary knife; they are elevated over the reciprocating knife shield (which prevents their being cut a second time) and started up the incline. The extra throat springs hold the stalks more firmly against the gatherer chains. The weeds and grass pass along the side of the shield to the reciprocating knife and are cut, thereby preventing clogging in the binder throat.

Exhaustive tests in the field in 1928 under a wide variety of soil and field conditions demonstrated the practicability of the device. A preliminary bulletin showing farmers how to build the attachment for two makes of binders, was issued last fall.

Does the Oil Filter Make Crankcase Draining Unnecessary?

By A. H. Hoffman[1]

FREQUENT draining of the oil from the crankcase has become a habit with probably the great majority of users of automobiles. Removing the grit with the oil has no doubt saved in decreased engine wear enough to pay many times over for the discarded oil.

But now comes the modern automobile equipped with an oil filter, the purpose of which is to remove solid impurities from the lubrication system. We are led at once to ask whether we should continue as before to "drain at 200 miles, then after 500 more miles and thereafter after each thousand."

The U. S. Bureau of Standards tells us that an oil does not wear out from use. However, other troubles may arise. The viscosity or body of the oil in the crankcase may be cut down by dilution with gasoline that escapes past leaky piston rings until the oil may become too thin to lubricate properly. Besides this dilution trouble there may be corrosion from accumulation of acid due to excessive sulphur in the gasoline. Especially in cold weather and when a car is used only for short runs with many starts and stops, and particularly if the driver is careless in the use of the choke, these troubles will be increased. Also in cold weather there is a greater tendency for water vapor (formed from the burning of the hydrogen in the gasoline) to condense in the crankcase. Under certain circumstances this water may mix with other substances in the oil and form a jelly-like sludge that will not circulate well through the lubrication system of the engine. These possible troubles look ominous; but it may be that we have magnified them unduly and may economize on oil without danger of harm to our engines if they are equipped with oil filters.

With the idea of getting some information concerning these changes in viscosity and acidity, the test here reported was made. It is hoped that it may prove of interest; however, it should be pointed out and emphasized that only one machine was in the experiment, and that in addition to the oil filter it had a crankcase ventilator and that both carburetor and breather were satisfactorily protected against the entry of dust. Further it should be noted that the test proper was made in warm weather, June and July, 1928.

A Buick "28-20" standard coach was run in this test from Davis, Calif., to Washington, D. C., and New York City and return, a total distance of 10,025 miles. Before the start of the trip the crankcase was drained and 6 quarts of "Pennzoil Extra Medium" (viscosity at 212 degrees [Fahrenheit] 58 seconds Saybolt and acidity 0.003 per cent) put in. Two-ounce oil samples were drawn from the test cock on the oil filter just before adding each lot of new oil purchased on the road. The new oil was also sampled. The crankcase was not drained until the mileage was 5098. Six quarts of "Pennzoil Extra Medium" (viscosity at 212 degrees 55.5 seconds Saybolt and acidity 0.004 per cent) was then put in and the rest of the trip, 4927 miles, was made without further draining. The intention was to eliminate one variable by using only one kind of oil for the whole trip; but when the original brand was not obtainable. "Mobiloil A" was called for. Evidently nearly all the oils bought were as represented; however, it is clear that there were some other oils substituted, one of which (2 quarts) was apparently one of the prediluted brands.

After the trip was over the oil samples collected were tested for viscosity and acidity with results for the two parts of the trip as given in the curves, Figs. 1 and 2.

The viscosities were taken by a ball-and-tube viscosimeter calibrated by comparison with a standard Saybolt. The viscosity given for each oil sample is the average of not less than six tests. The acidity determinations were made by the "total acid" method described on page 335 of Griffin's "Technical Methods and Analysis." All acidity tests were made at least in duplicate. As will be noted in Fig. 1, the viscosity curves are almost identical for the two halves of the trip. In both cases the viscosity reaches its low level before the new six-quart charge of oil has been in use 200 miles and does not change appreciably thereafter throughout the remainder of the 5000 miles. It

[1]Research specialist in agricultural engineering, University of California. Mem. A.S.A.E.

would therefore sem to be necessary to drain oftener than after each 200 miles if the object is to keep up the viscosity. The fact that in general the crankcase oil very quickly reaches a rather definite level of viscosity was established several years ago by tests made on the proving grounds of some of the automobile manufacturers. How low the level will be depends upon the oil used, the design of the machine, the average temperature of the crankcase, and the skill and care of the operator.

The points A, B and C on Fig. 1 show the viscosities of samples drained from the same machine subsequent to the long trip. In each case the date of sampling is given and the viscosity and miles run since the last draining are shown by the position on the graph. The A sample was in use from July 26 to October 11; the B and C samples from October 11 to the dates shown for each on Fig. 1. Aside from two trips of 84 miles each on October 12, no trips of more than 40 miles were made and the bulk of the mileages was made up of trips of less than 15 miles. Notwithstanding the short trips and the cooler weather the viscosities still fall close to the level for the long trips. Only the B sample was tested for acidity, with the result as shown on Fig. 2.

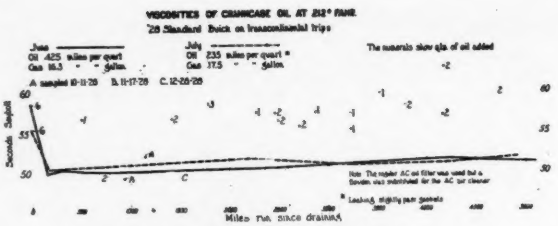
On January 10, 1929, the cylinder head was removed from the engine on which these tests were made and the combustion chambers and cylinder walls inspected. No evidence of scoring or undue wear was found and the valves were all in good condition.

Further evidence that the engine did not suffer because of the infrequency of crankcase draining is furnished by the chemical analysis of the solids in the oil filter that was on the machine during the 10,000 mile trip. The total ash per 1000 miles (including silica, iron, copper, lead, tin, chromium, and a number of other metals) is appreciably less than the average for nine other machines on which analyses of filter contents were made. It should be stated however, that the use of an air cleaner of high efficiency was in a considerable measure responsible, jointly with the oil filter, in keeping wear at a minimum.

While not quite so convincing as the curves for viscosity, the curves for acidity show much the same character, namely, a rapid rise in acidity to something like a normal level in the first 200 or 300 miles after draining and not much change thereafter. The high peak on the curve for the returning (July) trip is not due to a mistake in the determination. The titration for this sample was repeated five times. Two possible explanations may be given: The new bottle into which the sample was drawn may have been contaminated, or it may be that the gasoline used shortly before the sampling was abnormally high in sulphur content. No attempt was made to obtain highly refined gasoline. Usually the cheapest was purchased. One on or two occasions "doped" gasolines were purchased when no other was available.

Even the highest amounts of acid found are very small and probably would do no harm in the engine. Corrosion tests using strips of bright copper showed practically no effect even when protracted for several weeks.

Other factors, entering into this test should be mentioned. It will be noted that the oil mileage was 425 miles per quart going and only 235 miles per quart returning. (In making these calculations the four quarts drained from the crankcase after each half of the trip was subtracted from the total purchased.) The large difference in oil consumption was due principally, if not wholly, to difference in leakage past crankcase gaskets. Crankcase bolts and capscrews were tightened up just before the trip. Leakage was noticeable during the returning trip and no doubt added a bit to the black stripes so noticeable on concrete pavements. After the return the bolts were given proper attention and the oil mileage rose again to nearly its original value. The tendency of leakage would be to keep up viscosity and to keep down acidity by the partial draining and more frequent addition of new oil. That this effect was inconsiderable seems clear from the curves.



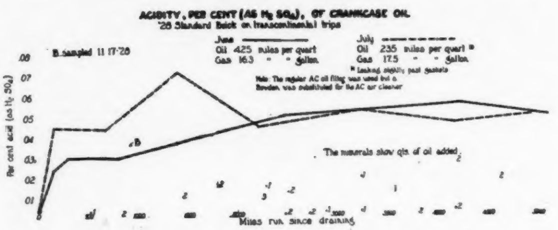


Fig. 1. (Top) Curves showing the viscosities of the crankcase oil in the tests conducted by A. H. Hoffman and described in the accompanying article. It will be noted that the curves are almost indentical for the two halves of the trip. Fig. 2. (Bottom) Curves showing the acidity on the crankcase oil at various stages of the 5000-mile trip, as determined from the Hoffman tests

During the first part of the going trip the carburetor was adjusted for somewhat too rich a mixture and during the rest of the trip might well have been a little leaner than it was. This would tend to greater dilution and lower viscosity. On the other hand, the mixture heater was left on practically continuously, which would have the effect of making combustion more complete and therefore reducing dilution.

Like most other accessories, an oil filter needs attention periodically. Usually renewal or thorough servicing (depending upon the construction) is required after 10,000 miles of ordinary use. The writer has seen the interiors of quite a number of filters that had had much longer service; in one case the filter had been neglected until 53,000 miles had been run. Practically every make of filter is equipped with a by-pass valve which allows the oil to get by unfiltered when the restriction becomes too great. Not only do the filters when neglected for too long become full of solid matter, but in some cases the filter materials themselves have been found to deteriorate and to become weak and break, thus allowing the oil to pass unfiltered. It is usually a simple matter to find out whether the filter is operating. If the oil is no longer being filtered, a sample from the crankcase will appear dirty.

In conclusion it should be repeated that the principal data here given involve but one machine and one summer trip. If the results are corroborated by additional tests it would appear that money is being wasted in too frequent drainage of the crankcases of the later model automobiles.

A.H.E.A. Admitted to A.S.A. Membership

THE American Home Economics Association some time ago accepted an invitation to become a member of the American Standards Association. This action is a step in the development of consumer representation in the standardization movement in America, as provided for by the reorganization into the American Standards Association of the outgrown American Engineering Standards Committee. It is taken as an indication of growing recognition of the importance of the household consumer and will lead to further study of her place in our economic system, a subject in which the home economists are much interested.

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

Water-Finder Work in the Bombay Presidency, D. L. Sahasrabuddhe (Bombay Department of Agriculture, Bulletin 152 (1928), pp. 47, pl. 1).—An instrument for the location of underground water supplies, using the principle of the magnetic needle, is described, and the results of actual tests are reported. The latter showed "that in a country where at least 40 per cent of wells under normal circumstances are failures even in selected sites, wherever the automatic water-finder has indicated water, and a careful test, including boring has been made, water has been found. As a rule the supply indicated has been within the depth of well sinking; in a few cases subartesian water has been found by boring at varying depths up to 126 feet.

"It would seem, therefore, sufficiently proved that under the conditions which prevail in the trap areas of western India where underground water occurs in well defined streams flowing in rock fissures, sometimes under little or no pressure, and sometimes under considerable pressure, the water finder can be used with advantage in locating streams of water which can be tapped either by well digging or by boring."

Engineering Problems Manual, F. C. Dana and E. H. Willmarth (New York and London: McGraw-Hill Book Co., 1927, pp. XVIII + 187, figs. 53).—This manual, based largely upon practice at the Iowa State College, presents practical examples of the coordination of mathematics, physics and practical engineering, together with a large amount of useful related data. It contains chapters on specifications for computation sheets, aims of engineering problems courses, some basic principles and notes on their use, notes on mathematics, computation methods, review problems and miscellaneous tables.

Public Roads, [January, 1929] (U. S. Department of Agriculture, Public Roads, 9 (1929), No. 11, pp. 209-224 + [2], figs. 26).—This number of this periodical contains the status of federal-aid road construction as of December 31, 1928, together with the following articles: Model Analysis of a Reinforced Concrete Arch, by J. T. Thompson (pp. 209-220); Influence of Mineral Composition of Sand on Mortar Strength, by E. C. E. Lord. (pp. 221, 222); and A Proposed Abrasion Test for Sand Investigated, by D. O. Woolf (pp. 222-224).

Refrigeration, J. A. Moyer and R. U. Fitts (New York and London: McGraw-Hill Book Co., 1928, pp. VII + 431, figs. 186). —This is a handbook on refrigeration, including particular reference to household automatic refrigerating machines. It contains chapters on refrigeration methods, systems of refrigeration, properties of refrigerants, compressors for refrigerating plants, household mechanical refrigeration, operation of refrigeration systems, thermodynamics of refrigerating systems, refrigeration economics and plant testing, ice making, cold-storage construction, air circulation and ventilation in cold storage, cold storage of foods, and air conditioning and cooling; and an appendix on problems in refrigeration, and one containing tabular and graphic working data.

Research in Refrigeration (Cold Storage, 31 (1928), No. 369, pp. 392, 393, 406, figs. 2).—An account is given of some of the methods and apparatus described by E. Griffiths before a meeting of the British Association of Refrigeration, which have been successfully used in refrigeration research. Among these are a spear thermometer for temperature measurements in meat carcasses, a carbon dioxide measuring method based on sound velocity records, a special hygrometer, a dew deposition recorder, and methods for determining the heat generated by stored fruit and the internal pressure in meat during freezing.

Power's Practical Refrigeration, Compiled by L. H. Morrison (New York and London: McGraw-Hill Book Company, 1928, 2. ed., pp. VIII + 259, figs. 103).—This is the second edition of this book. It contains chapters on elementary refrigeration, the evaporating system, compressors, condensers, installing refrigerating machinery, insulators, notes on rainwater ice making, the absorption refrigerating system, the carbon dioxide refrigerating machine, and testing compression plants.

The Influence of Various Factors on the Power and Economy of a Gasoline Engine, E. A. Allcut (Engineering Journal (Montreal, Can.) 11 (1928), No. 11, pp. 549-559, figs. 13).—In a contribution from the University of Toronto, a large amount of data from tests bearing on the subject are reported and discussed.

One of the first conclusions drawn is that there is no economic advantage in buying antiknock fuels at a 3-cent premium if an engine having a compression ratio of 5.5:1 can be operated satisfactorily on an ordinary gasoline. The data also indicate that the cooling water temperature has no appreciable effect on the brake horsepower or on the brake thermal efficiency.

It was also found that there is no gain in power or economy by using special lubricants in fuels, although there may possibly be some beneficial results so far as the running surfaces are concerned.

Motor Driven Green-Feed, Root and Straw Choppers, F. E. Price, G. W. Kable, and F. E. Fox (Oregon Station (Corvallis) Circular 88 (1929), pp. 8, figs. 7).—This circular deals with the small cutters used on poultry or dairy farms for chopping kale and green alfalfa for hens and chicks, roots for hens and cows, straw for chick litter, and small quantities of hay for feeding livestock.

It was found that when a hand-power green feed cutter is operated by a small electric motor the number of pounds cut per hour is increased approximately three times. Cutters having throats up to 10 inches may be operated by a ½ or ¾-hp. motor. Cutters may be run at speeds up to 350 r.p.m. A very satisfactory speed for the larger hand machines is 200 to 250 r.p.m.

Quantitative Antiknock Testing, C. K. Reiman (Industrial and Engineering Chemistry (Washington, D. C.) 19 (1927), No. 9, pp. 1055-1058, fig. 1).—A method of measuring the antiknock quality of motor fuels is explained in detail. Provided there is but little difference in antiknock value between the unknown sample and the known aniline standards used in the final comparison, it is shown that the same result is obtained whether the comparison is made at high or low speed, high or low compression, high or low power output, with heavy or light knocking, rich or lean mixture, and regardless of the timing of the spark. Quantitative results on a series of fuels are included.

A High Pressure Gas Compression System, J. R. Dilley and W. L. Edwards (U. S. Department of Agriculture Circular 61 (1929), pp. 19, figs. 12).—This circular describes the operation of a system for experimental work with gases at normal temperature and at pressures up to 1,500 atmospheres (22,500 pounds per square inch). Detailed drawings of each piece of equipment are shown, permitting the complete construction of the system described. Descriptions of the apparatus, together with approximate costs of its various parts, are included.

Plows and Good Plowing, C. O. Reed and E. A. Silver (Ohio Agricultural College (Columbus) Extension Bulletin 80 (1928-29), pp. 61.—This bulletin presents pertinent and practical hints relating to the important adjustments of plows and to good plowing practice in Ohio, with particular reference to the control of the corn borer.

The International Trade in Farm Machinery, K. Ritter (Berlin Landwirtschaft Reichsmin. Ernahr. u. Landwirtschaft [Germany], n. ser., 6 (1928), No. 4; also in Agrarpolit. Aufsatze u. Vortrage, No. 10 (1928), pp. 48).—Data are presented on the world production, marketing and distribution of farm machinery.

Measured Pulling Power of Many Teams Studied (Illinois Station (Urbana) Report 1928, pp. 161, 162).—Experiments on the pulling power of 269 teams, using the Collins dynamometer, showed that massive build, energetic but calm disposition, and steady driving are the main factors in success in pulling.

A Study of the Failure of Concrete Under Combined Compressive Stresses, F. E. Richart, A. Brandtzaeg, and R. L. Brown (Illinois Engineering Experiment Station (Urbana) Bulletin 185 (1928), pp. 104, figs. 36).—Tests of mortar and concrete covering the usual range of mixtures showed that in general the strength of the material in biaxial compression was as great as in simple compression, and that in many cases it was greater. The strength of the concrete in triaxial compression was found to increase greatly with the magnitude of the smallest principal stress. The tests of concrete of lean, medium, and rich mixtures in triaxial compression showed that the rate of increase in the strength with increase in the smallest principal stress was largely independent of the proportions of the concrete mixture. The triaxial compression tests showed that the presence of lateral pressures

added to the strength of the specimen an amount approximately 4.1 times the magnitude of the lateral pressure.

The high stresses resisted by the concrete in triaxial compression were always accompanied by very large deformations. The axial deformation at maximum load ranged from 0.5 to more than 7.0 per cent of the length of the specimen, depending on the magnitude of the stress and the quality of the concrete. Much of the deformation under triaxial loading was due to an inelastic reduction in volume, or a compacting, of the concrete under stress. The amount of compacting varied considerably with the richness of the mixture.

The tests of concrete in simple compression showed characteristic differences in behavior throughout three distinct stages of loading. In the first stage, the action was nearly elastic; in the second stage, an appreciable part of the deformation was inelastic and the action was marked by an increase in the rate of deformation and in the ratio of lateral to longitudinal deformation; in the third stage, which began at loads 75 to 85 per cent of the maximum load, a general breakdown of the internal continuity of the material developed. In this stage there was a very great increase in the lateral deformation, which finally produced an increase in volume under continued loading, indicating by this lateral bulging that a splitting failure was taking place throughout the material on surfaces parallel to the direction of the applied compressive stress. The tests in biaxial and triaxial compression also indicated that a process of splitting similar to that found in simple compression was prominent in the failure of the material upon those combined stresses.

Integral Waterproofing Compounds for Concrete, M. B. Lagaard (Minnesota University, Engineering Experiment Station (St. Paul) Bulletin 6 (1927), pp. [6] + 25, figs. 12).—Tests of twelve commercial waterproofing compounds and two waterproof cements are reported.

The results show that of the fourteen materials tested, thirteen caused a marked reduction in the strength in some concrete mixes. The effectiveness of these materials as waterproofing agents varied greatly. In some cases the concrete was consistently made more water-tight and in others the effect was only slight. With a number of the compounds, the results showed beneficial effects for some mixes and harmful effects for others. This introduces the factor of uncertainty as far as their value for waterproofing is concerned. In one case the compound was harmful throughout. In no case was there noticed a tendency to increase workability and in many cases the effect was to decrease it materially.

The use of many of these materials added to the burden of the mixing operations, in that special handling of the compounds was required.

The results on the standard mixes without waterproofing agents tend to confirm those of other investigators that a richer mix of portland cement produces a more water-tight concrete, and at the same time increases the strength and the workability of the concrete.

In tests of plain concrete the permeability was found to decrease rapidly with decrease in the water-cement ratio, thus bearing out other tests, indicating that a drier mix will improve the waterproofing quality of the concrete.

A Principle for Testing the Durability of Paints as Protective Coatings for Wood, F. L. Browne (Industrial and Engineering Chemistry (Washington, D. C.) 19 (1927), No. 9, pp. 982-985, figs. 3).—In a contribution from the U. S. D. A. Forest Service the basic principle is set forth of a technique for measuring the degree of protection afforded by paint coatings against the weathering of wood and the change in their protective power as the coatings themselves deteriorate during exposure.

It was found that the durability of paints as protective coatings can be measured by observing their effectiveness in retarding the absorption of moisture from saturated air by painted wood panels at intervals during the exposure of the panels to the weather. Paints of different composition may have very different life histories with respect to moisture-excluding effectiveness, and neither the time of initial chalking nor of initial exposure of wood through coating disintegration can be relied upon as a general indication of the durability of the effectiveness of the coating. During the early part of the life history of an initially adequate protective coating the amount of moisture absorbed by coated wood panels is a characteristic of the coating rather than of the wood; that is, the absorption is about the same regardless of the kind of wood coated. During the latter part of the life history of the coating the influence of the wood becomes noticeable. In test-fence results indications of the deterioration in moisture-excluding effectiveness of the coatings were given by the obvious beginning of wood weathering under coatings that still remained intact.

Effect of Temperature on the Strength of Concrete, C. C. Wiley (Engineering News-Record (New York) 102 (1929), No. 5, pp. 179-181, figs. 2).—Studies conducted at the University of Illinois are reported, leading to the conclusion that all concrete should be protected from freezing for at least one week at a temperature of 70 degrees (Fahrenheit) or twice as long at a temperature of 35 degrees. This is a radical departure from the common assumption that it is only necessary to protect concrete from freezing until it has attained final set. This freezing of concrete at an early age with the consequent permanent damage offers an explanation of the failure of certain structures built during cold weather.

Slag, Coke Breeze and Clinker as Aggregates, F. M. Lea and F. L. Brady ([Gt. Brit.] Department of Science and Industrial Research (London) Building Research Board Special Report 10 (1927), pp. V + 22, pl. 1).—Experiments are reported which showed that slag will make a sound and strong concrete provided that the slag is neither very acid nor strongly basic. It is often better to use only the coarse slag and reject the fines, using sand instead. This not only yields a stronger product, but also obviates possible danger due to the activity of these fines. Coke-breeze concrete is usually rather weak mechanically and is unsuited for use in outside or wet situations, but it has the very important advantage of yielding a light product which can be used for internal walls. Coke breeze may also be usefully employed together with sand as a fine aggregate.

Protecting Wood with Aluminum Paint, J. D. Edwards and R. I. Wray (Industrial and Engineering Chemistry (Washington, D. C.) 19 (1927), No. 9, pp. 975-977).—Data are reported to show that paint coatings continue to protect wood adequately against weathering only as long as they maintain a reasonable degree of moisture-excluding efficiency.

It is further shown that coatings having a moisture-excluding efficiency still higher than the traditional house paints afford materially greater protection against wood weathering. Aluminum paints or coatings made up of a priming coat of aluminum paint covered by ordinary house paints are highly impermeable to moisture and are especially effective in preventing wood weathering and are very durable.

[Agricultural Engineering Studies at the Oregon Station] (Oregon Station Biennial Report 1927-28, pp. 109-111).—The progress of experiments on prune dehydration is reported, indicating that the use of electric fans for re-circulating the air in prune driers increased the capacity of the plant, made the production of a better product possible, and enabled the operators to have more certain control of the process of drying. It was found that adding a motor-driven fan to the Oregon tunnel type of drier produced results approximately equal to the more costly driers of newer type which were being constructed. One of the outstanding results of the investigation was the discovery that prunes dry more rapidly at high initial temperatures and low finishing temperatures, and with low relative humidity at the beginning of the process and high relative humidity at the end of the drying period. These conditions are the reverse of those existing in the present type of driers.

Handbook of Domestic Oil Heating, edited by H. F. Tapp (New York: American Oil Burner Association, 1928, pp. 383, figs. 153).—This handbook gives information concerning the problems of combustion and heating that is necessary in the use of oil heating equipment. It contains the following chapters: Definitions and terms, heat transfer and heating requirements, oil as fuel, characteristics and properties of fuel oil, comparative fuel costs, fuel oil combustion, oil burners and controls, oil fuel storage, oil pumps and piping, boilers and furnaces, hot water and steam heating systems, warm air heating, inspection and survey of heating plant, installations and tests, sales and services, ordinances and oil heating, oil heating and the architect, and miscellaneous tables and information.

Plain Concrete, E. E. Bauer (New York and London: McGraw-Hill Book Co., 1928, pp. XI + 346, figs. 131).—This is a textbook and laboratory manual on plain concrete. It contains chapters on introduction; standard portland cement; special cements; mineral aggregates; mixing water and admixtures; theories of proportioning; making of concrete; placing, finishing and curing of concrete; field control of concrete; workability and waterproofness; high early strength concrete; estimating quantities of materials for concrete; specifications; sampling; and testing. Appendixes include a large amount of working data.

Book Review

"Tractor and Implement Blue Book" for 1929 is the 27th annual edition of this tractor and implement directory of the United States. Although many changes and additions have been made, the convenient pocket size has not been outgrown. The volume includes an index to advertising; implement classification; tractor section, containing specifications of tractor and other "heavy line" farm machinery, and other useful data; an alphatetical list of farm equipment manufacturers; and other valuable features. It is published by the Midland Publishing Co., St. Louis, Mo., and sold for 50 cents per copy.

Who's Who in Agricultural Engineering

F. C. Fenton

Hobart Beresford

F. R. Jones

Henry Giese

F. C. Fenton

Frederic Charles Fenton (Mem. A.S.A.E.)—vice-chairman of the A.S.A.E. Structures Division—is professor and head of the department of agricultural engineering at Kansas State Agricultural College. After Iowa State College granted him a bachelor's degree in agricultural engineering in 1914 it retained him in its extension service until he accepted a similar position at the University of Missouri in 1916. The war took him to France as a first lieutenant of artillery, where he served for nearly two years as an instructor in artillery schools. Following the war he attended Oxford University in England for one term before returning to the United States. Reverting to civil life in 1919, he became associate professor of agricultural engineering, in charge of instruction in farm structures, at Iowa State College. In July 1928 he resigned this position for the one he holds at present. He has been active in the Society since 1917 and is at present chairman of both the committee on cooperative relations and the committee on animal shelters and a member of the College Division advisory committee.

Hobart Beresford

Hobart Beresford (Mem. A.S.A.E.) is professor and head of the department of agriculural engineering and agricultural engineer for the Agricultural and Engineering Experiment Station of the University of Idaho. He received his bachelor's degree in agricultural engineering in 1924. Appointment as instructor in agricultural engineering and Assistant experiment station agricultural engineer in the College of Agriculture at the University of Idaho was made in September of the same year. He was advanced to an assistant professorship from which he resigned in 1927 to become agricultural engineer and superintendent of rural service for the Idaho Power Company. The results of the organization, supervision, and training of the personnel of this newly created department are reported in bulletins and progress reports dealing with rural electrification in Idaho. In 1928 he returned to the University of Idaho as head of the reorganized department of agricultural engineering, under the joint supervision of the deans of the college of agriculture and the college of engineering. In this position he also serves as secretary and project director for the Idaho Committee on the Relation of Electricity to Agriculture.

F. R. Jones

Fred Rufus Jones (Assoc. Mem. A.S.A.E.)—member A. S.A.E. Council—is associate professor of agricultural engineering at Texas A. & M. College, having charge particularly of farm power and home utilities instruction work. He was reared on a Wisconsin farm and obtained his early education in that state. Following his completion of the four-year course in agriculture at the University of Wisconsin in 1915, he was made an instructor in agricultural engineering in that institution. In 1917 he went to Mississippi as farm machinery extension specialist, and in 1918 entered military services as a lieutenant in the Marine Air Corps. At the close of the war he spent two years in tractor and implement sales work and in 1921 made his present connection in Texas. He has prepared a number of bulletins, papers and articles on the use of improved machinery in the South and during the past three years has devoted considerable time to a study of the use of mechanical power for cotton production in Texas. In the Society he is chairman of the Southwest Section.

Henry Giese

Henry Giese (Mem. A.S.A.E.) is associate professor of agricultural engineering at Iowa State College. He had several years of experience as a teacher of mathematics, English and manual training in public and private schools in Iowa before he entered Iowa State College in 1916. From 1914 to 1918 he spent his summers at Iowa State College teaching manual training courses for teachers of this subject. For the last two of these summers he was in charge of the work. Upon receiving his bachelor's degree in architectural engineering in 1919 he was employed by the U. S. Veteran's Bureau to supervise the training and placing of government trainees in District 4 and particularly at Iowa State College. After a short period as instructor in industrial arts in the Dubuque, Iowa, public schools he became instructor in mathematics at Iowa State College and soon, in 1923, became a member of the staff of the agricultural engineering department. He recently received an appointment as senior agricultural engineer of the U. S. Department of Agriculture to direct a survey of research work in farm structures.

AGRICULTURAL ENGINEERING

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Contributions of interest and value, especially on new developments in the field of agricultural engineering, are invited for publication in this journal. Its columns are open for discussions on all phases of agricultural engineering. Communications on subjects of timely interest to agricultural engineers, or comments on the contents of this journal or the activities of the Society, are also welcome.

Original articles, papers, discussions, and reports may be reprinted from this publication, provided proper credit is given.

RAYMOND OLNEY, Editor

R. A. Palmer, Assistant Editor

Nourse on Tractors

ABOUT a year ago the Committee on Recent Economic Changes, of the President's Conference on Unemployment, was appointed. Dr. Edwin G. Nourse, chief of the agricultural division of the Institute of Economics, was appointed to study changes in agriculture. In the recently published report of this committee was a chapter on tractors by Dr. Nourse.

"Tractors on farms," said this noted economist, "have not merely replaced horses and mules, but have changed the whole character of American agriculture. . . . . .

". . . . . . we are slowly coming to perceive that it (the tractor) sets a new pace and rather than fitting itself unobtrusively into our agriculture, creates a demand that agriculture be quite drastically adjusted in accordance with its needs and potentialities. . . . . . ."

While this is no new idea to agricultural engineers, it is pleasantly reasurring to find it gaining acceptance and publicity in this manner.

Furthermore, it is challenging, for while agricultural engineers are largely responsible for bringing the tractor to its present state of development, and while they have realized that it must necessitate many readjustments in agriculture, they have only begun to obtain, analyze and apply data on production principles and methods adapted to tractor power.

Agricultural engineers have only gone half way on this tractor job until they have shown how agriculture can be remodeled to make full application of the potentialities of the tractor.

Professional Contacts

NO MAN can achieve distinction and the largest measure of success in his profession, if he feels that he is sufficient unto himself—if he fails to make important contacts with others in the same work.

It is a noteworthy fact in the agricultural engineering profession that the men, who have made the most progress in this field and who have received the most recognition are the ones who have felt the importance of these professional contacts, and who have not only held membership in their national society but have consistently attended its meetings.

A Broad Definition

ACCORDING to the American Engineering Council, "Engineering is the science of controlling the forces and materials of nature for the benefit of man, and the art of organizing and directing human activities in connection therewith."

Four questions arising out of this definition are: (1) What is of benefit to man? (2) What are the forces and materials of nature, their characteristics and the natural laws governing their control and utilization? (3) What are the principles to be followed in the control and utilization of these forces and materials to make them of greatest benefit to man? (4) What are the principles involved in the organization and direction of human activities?

The definition implies that engineers should have answers to these questions. What are the fields of knowledge involved? The first question lies in the field of philosophy; the second, in the field of the natural sciences; the third and fourth, in the fields of economics, sociology and psychology.

How far have engineers gone in acquiring a knowledge of these fields that would enable them to qualify as engineers under the definition given? The first question has been easily disposed of by accepting the premise that material welfare is beneficial to man.

To the second question the engineers have given the major portion of their attention. They are past masters of analysis and application in mathematics, physics, chemistry, etc. While there are important forces of nature to which they have given little attention, they have shown their ability to master these forces whenever and wherever the need has arisen.

The third and fourth questions, and the sciences of economics, sociology and psychology they involve, have for the most part been neglected by engineers. While they have mastered the knowledge of and the technique of using the forces and materials of nature, they have for the most part been content to guess or to accept the advice and direction of others as to the needs of man and the application of man power.

If engineers have minimized the importance of economics, sociology and psychology, perhaps it is because these sciences have not been presented to them from their own viewpoint. For example, a noted teacher and author of economics in a recent book has written "We must peer into the future in the light of the past." This statement, and much of the author's subsequent reasoning based on it, gives absolutely no consideration to the effect upon economic conditions of the future which certain technical developments are sure to have. In past ages when technical developments were almost negligible, the past must have been a fairly complete guide to the future. At present, however, to "peer into the future in the light of the past" without also turning on the light of the influence of technical progress—changing means and rates of transportation and communication, new wants, new standards of living—must reveal an incomplete and erroneous picture. Naturally it takes only a few such statements as quoted to disgust the engineer with the subject of economics as he finds it.

Whatever the cause, the effect of engineers having limited knowledge in economics, sociology and psychology, is to limit their field and their achievements. No one knows more than engineers do about the forces and materials of nature and what can be done with them. Many people know more than engineers about people and ways in which they might be benefited. Only when engineers combine a broad knowledge along both of these lines can they see and avail themselves of their greatest opportunities and live up to the definition they have given their profession.

A. S. A. E. and Related Activities

Agricultural Engineers Welcomed at Dallas

"WELCOME, American Society of Agricultural Engineers" were the words of a twelve-foot sign which hung across one end of the Baker Hotel lobby in Dallas, June 24-27. It greeted somewhat more than 200 agricultural engineers and guests as they entered and made their way up to the mezzanine floor to register for the 23rd annual meeting of the Society. Incidentally, this sign became, to others about the Baker Hotel and city, a symbol of sobriety and industry, and of progress in the direction of greater mutual rural and urban prosperity.

The meeting focused attention on agricultural engineering problems and opportunities of the South; helped those who came from more northern localities to gain a better understanding and appreciation of the South; and undoubtedly will stimulate more progress in the application of engineering to southern agriculture.

Soil erosion was pictured as a national menace by agricultural engineers and others most familiar with the situation, in the first day of general sessions. More attention was given to this than any other one particular problem of agricultural engineering. Cotton harvesting, which creates the greatest labor peak in the section where it is grown, and which is just now in the early stages of mechanization, ran a close second for interest. In the president's annual address, published elsewhere in this issue, William Boss pointed out that the agricultural engineer has a part in safeguarding and adding to the present high state of civilization; that it is his responsibility to intelligently apply to agriculture the same forces of nature, the application of which has made enormous and significant changes in other lines of industry.

Through the courtesy of Hickman Price, large scale wheat farmer and a member of the Society, M. H. Thomas, who is known as the largest cotton broker in the South, gave a highly humorous and inspiring talk on the Wednesday morning program.

Most of those who attended were on hand for the College Division meeting on Monday morning. Discussion at this meeting was lively, especially on E. R. Jones' paper, entitled "Farm Self-Sufficiency Returning." The simultaneous technical division sessions on Thursday afternoon presented all the difficulties of a three-ring circus to such men as were interested in the meetings of more than one division. Extension men, the college agricultural engineering department heads and men interested in grain drying were among the groups which managed to sandwich meetings in between the regularly scheduled sessions. The rural electric project directors and others interested in their work held their annual reunion on Friday.

At the business meeting Tuesday evening practically complete committee appointments for the coming year were announced by President Kaiser and the division chairmen. The Resolutions Committee presented, at the annual dinner Wednesday evening, resolutions encouraging increased support of state and federal agencies for research and extension programs in erosion control; urging land grant colleges to give increased support to agricultural engineering research and education; and thanking the various individuals and organizations contributing to the success of the meeting, were among those approved.

Every one at the annual dinner received in addition to the meal and entertainment, a yo yo, a boll of cotton, and an invitation to attend the annual meeting in Moline next year. Perhaps the high spot of the entertainment was the barbecue and watermelon cutting Thursday noon. After an interesting and instructive morning spent in visiting a cotton gin and a ginning machinery factory, and field demonstration of cotton dusting by airplane and of terracing, every one was ready to rest and eat in a shady grove of the Holland Farm. There one had only to help himself to cold bottled soft drinks. Watermelons were quartered and riddled. Barbecue sandwiches were of characteristic Texas proportions. The crowd was late in getting back to the Hotel for the afternoon sessions.

The cooperation of the Texans was gratifying at every turn. Radio Station WFAA in the Baker gave a short period each noon to talks by President Kaiser and other prominent members of the Society. The Dallas Morning News pictured the outgoing and incoming presidents and each morning gave a detailed account of the program and principal papers of the preceding day.

Attendance outran expectations. Ohio men claimed the distinction of having the largest representation of any college agricultural engineering department. Many of the members brought their families, who were well entertained by the ladies committee. Along with valued ideas and technical information, every one carried away pleasant memories and anticipations of the meeting next summer at Moline.

Engineering Section Provided for in Institute of Rural Affairs

ENGINEERING will take its place alongside of economics and sociology in the Institute of Rural Affairs to to be held by the Virginia Polytechnic Institute at Blacksburg, July 30 to August 2. The Institute of Rural Affairs is a new departure in Virginia and will be held concurrently with the State Farmers' Institute, the former occupying the forenoons, the latter the afternoons and the two holding joint meetings in the evenings.

C. O. Reed, professor of agricultural engineering at Ohio State University, has been selected to lead the engineering section. "The Effect of Farm Power and Machinery on Agriculture," is the general subject for discussion in this section on Wednesday morning, July 31. Mr. Reed will make the opening contribution on "Problems Arising from the Application of Modern Machinery in Farming." Following a discussion on this, V. R. Hillman, agricultural engineer, Virginia Polytechnic Institute, will speak on "The Effect of Machinery on Production Costs" and S. P. Lyle, head of the department of agricultural engineering, University of Georgia, will speak on "The Use of Adapted Machinery in Crop Production."

"Rural Electrification" will receive the attention of the section on August 1. With Mr. Reed leading, Geo. W. Kable, director of the National Rural Electric Project, will open the subject with a talk on "The Rural Electrification Problem," and following the discussion, E. W. Lehmann, head of the department of farm mechanics, University of Illinois, will speak on "How Electric Power May be Applied to Farming."

Miss Eloise Davison, home economics advisor, National Electric Light Association, will be the opening speaker on the "Labor Saving in the Farm Home," program Friday morning, August 2. Her subject will be "More Power to the Farm Home." P. B. Potter, agricultural engineer, Virginia

Polytechnic Institute, will speak on "Water and Air in Relation to Comfort and Health." Following a discussion of these subjects Mr. Reed will close the meeting with a summary of all the discussions presented in the engineering section during its three half-day sessions.

Engineering will also be given important emphasis in the Farmers' Institute program. One joint meeting of the home economics and agricultural engineering section has been arranged. Its attention will be given to farm home equipment. Another session will be devoted to power and machinery.

Subjects on the Thursday evening program which will be of particular interest to engineers are "Industry's Interest in Agriculture, " by Louis J. Taber, Master of the National Grange, and "Agriculture's Interest in Industry," by Dr. Gus Dyer, Vanderbilt University.

American Engineering Council

SEVERAL matters of interest to agricultural engineers were taken up by the administrative board of American Engineering Council when it met in Washington, May, 24. President William Boss of this Society represented it at the meeting.

The board approved a recommendation of its executive committee that Council exercise its influence to secure larger appropriations for the topographic mapping of the United States. Specifically, it recommended that Council reiterate its stand in favor of additional appropriations for first and second line triangulation and topographical mapping; that the executive secretary call to the attention of the President and of the Secretaries of Commerce, Interior and War to the need for additional work along these lines and to the desirability of providing for it in their budget recommendations; and that Council be authorized to secure strong representatives before the congressional appropriations committees and Bureau of the Budget hearing on these items.

The further triangulation and topographic mapping proposed would produce data of value to science, agriculture, industry and various branches of the government. Floods and flood control controversies of the past few years have particularly emphasized the need of increased topographic data.

Gardner S. Williams is chairman, and Baxter L. Brown, John R. Freeman and Arthur E. Morgan are members of Council's flood control committee. Their latest report, presented and approved at the administrative board meeting of May 24, points out that "Sufficient study of the engineering and economic phases of flood control on the Mississippi River has not been made to justify the federal government in adopting any plan therefor. Consequently it would be a grave mistake to permit the letting of contracts for the construction of the Missouri floodway or any other controversial elements until the engineering practicability and economical feasibility are adequately studied by a nonpartisan and competent board of engineers."

After outlining the situation in more detail the committee went on records as follows: " . . . . your committee urgently recommends the creation by the federal government of a board of review composed of non-partisan and competent civilian engineers with authority to develop the best possible solution of the Mississippi flood control problem.

"And your committee further recommends that the said board of review should as soon as practicable designate those features of construction which would be common to any acceptable plans, whereupon work should proceed upon them, and that pending such designation, work should be restricted to the repair, strengthening, and raising of existing structures and the construction of the Bonnet Carre spillway."

Through a new committee on engineering and allied technical professions Council is initiating a program to improve the general status of the engineering profession. The functional outline and personnel for this committee also recieved the favorable action of the board. It will study and act in an advisory capacity on matters of earnings of engineers the status and major trends of the engineering profession, classification and registration of engineers, technical education (as a professional responsibility), corollary questions and objectives of the profession.

Matters to which Council has called attention recently include the fourth biennial conference of secretaries of engineering societies, sponsored by Council which was held in Chicago, June 6; and the Muscle Shoals question which has again been revived in Congress.

American Standards Association

THE proposed American Recommended Practice for "Gear Materials and Blanks, Alloy Steel, Cast Steel, Forged and Rolled Carbon Steel, Bronze and Brass" (B 6f) was recently approved by a subcommittee of the Sectional Committee on the Standardization of Gears. Copies of the draft proposal are being circulated by the sponsors for review and criticism. A copy is available for loan. (Address A.S.A. Information Service, 23 West 39th Street, New York, N.Y.

In accordance with action taken by the Safety Code Correlating Committee on April 17, 1929, the proposed Safety code for Mechanical Power Control (B 23) will be formulated as an additional section of the Safety Code for Mechanical Power Transmission (B 15-1927) by a subcommittee recently organized.

The sectional committee on the standardization of shafting is now revising four of its standards. The present Standard for Cold-Finished, Standard Diameters and Lengths (B 17s) is being revised to include an extended range of shafting diameters of 6½, 7, 7½, 8, 10, 12, 14, and 16 inches. In the case of the standards for Standard Widths and Heights of Square and Flat Stock Keys (B 17d), Square and Flat Plain Taper Stock Keys (B 17d), and Square and Flat Gib Head Taper Stock Keys (B 17e), the revisions introduce the use of a 5/6-inch square key and a 5/16x¼-inch rectangular or flat key for use on shafting diameters ranging from 1¼ to 1⅜ inches. Copies of the four sheets are available for loan to those interested.

A draft of the "Proposed American Standard Slotted Head Proportions Machine Screws, Cap Screws and Wood Screws" (B 18c) is being circulated by the sponsors for review and criticism. Loan copies of the draft may be obtained.

As a part of their comprehensive program on specifications for Insulated Wires and Cables (C 8), the American Institute of Electrical Engineers have submitted to the A.S.A. their standard No. 30 covering terminology and certain methods of test for electric wires and cables.

The Underwriters' Laboratories have submitted for A. S.A. approval their Specifications for Outlet Boxes (C 27). These are a part of an extensive project on electrical devices and materials with relation to fire and casualty hazards for which the Underwriters' Laboratories hold sponsorship.

The sectional committee on the project "Scientific and Engineering Symbols and Abbreviations" are circulating a draft of the Proposed Tentative American Standard Abbreviations for Scientific and Engineering Terms (Z 10). The draft includes 285 abbreviations, and copies are available for loan, criticism and review.

A.S.A.E. Urges More Attention to Soil and Water Conservation

AT ITS 23rd annual meeting last month the American Society of Agricultural Engineers, recognizing that the conservation of soil and water resources is one of our great national problems and appreciating that prompt and extensive development of adequate methods of control is an immediate necessity, prepared, adopted and sent the following resolution to the Secretary of Agriculture:

WHEREAS the importance of soil and water conservation as developed at the 23rd annual meeting of the American Society of Agricultural Engineers if of fundamental importance to the future agricultural well-being of our country, and

WHEREAS the consequence of soil depletion by erosion as indicated by actual experience and research, shows that this is a problem of importance second to none facing American agriculture today, and

WHEREAS millions of acres of farm land have already been completely destroyed by erosion and the crop yields of millions of acres have been materially reduced from this cause, and

WHEREAS over a large part of the country crop production is materially reduced due to the lack of adequate moisture supply during the growing season, and

WHEREAS experimental evidence indicates that measures designed to prevent soil erosion serve also the important function of conserving moisture in areas of small annual rainfall, thus rendering it available during the growing season, and

WHEREAS certain banks of the country have recognized the importance of the situation to the extent that they will not loan money on eroding land but will loan it on protected land only, therefore, be it

RESOLVED that the U. S. Department of Agriculture and the various state agencies be respectfully urged to request suitable appropriations to organize research and extension programs adequate to the development of proper methods of control, and for the dissemination of all useful information on these matters.

U.S.D.A. to Conduct Study of Farm Structures Research

THE U. S. Department of Agriculture has undertaken an intensive study of research in the field of farm structures. A survey of such research now in progress will be made with an attempt to formulate a correlated program of investigations which will place the subject of farm structures on a plane with other lines of agricultural engineering research. Henry Giese, assistant agricultural engineer, Iowa Agricultural Experiment Station, has been appointed to direct this study, and has been attached to the staff of the Division of Agricultural Engineering, Bureau of Public Roads. Mr. Giese has done outstanding work in the field of farm structures research.

Farm buildings, as they exist today, are the result of a following of precedent without regard for the particular requirements of a particular structure, nor for economy in the use of space and materials. It is now realized that in order that farm buildings may be properly designed, the fundamental requirements must be determined as well as the best and most economical methods of meeting them. The study just inaugurated is the first step toward bringing about a logical solution of the farm building problem.

The American Society of Agricultural Engineers was largely instrumental in getting this project started. A resolution was addressed by the Society to the Secretary of Agriculture, setting forth the urgent need of more concentrated attention being given farm structures research, and requesting the Secretary to take up this subject as a project. This the Secretary agreed to do. The project will be conducted along lines somewhat similar to those followed in connection with the recent study of research in farm mechanical equipment, the results of which are contained in U.S.D.A. Miscellaneous Publication No. 38.

The specific object sought is to formulate a satisfactory program of research and to interest the agricultural colleges in undertaking and carrying to completion a correlated series of investigations, the results of which cannot but result in the betterment of structures on the farm.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the June issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Henry L. Boyer, commercial sales department, Goulds Pumps, Inc., Seneca, Falls, N. Y.

John S. Glass, extension agricultural engineer, Kansas State Agricultural College, Manhattan, Kans.

Archie H. Glaves, junior engineer, U. S. Department of Agriculture, 615 Front St., Toledo, Ohio.

Howard F. McColly, instructor in agricultural engineering, North Dakota Agricultural College, Fargo, N. D.

Transfer of Grade

Merle W. Bloom, engineering and development, General Implement Co., Racine, Wis. (Junior to Associate Member.)

F. Addison Lyman, managing director, Farm Fence Institute, Chicago, Ill. (Junior to Associate Member.)

H. H. Sunderlin, supervisor of training, Caterpillar Tractor Co., Peoria, Ill. (Associate to Full Member.)

Employment Bulletin

An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only Society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available" section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested. Copy for notices must be received at the headquarters of the Society not later than the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. There is no charge for this service.

Positions Open

AGRICULTURAL ENGINEER wanted to fill position as instructor or assistant professor in the department of agricultural engineering of one of the land grant colleges of the Northwest. A recent graduate in agricultural engineering qualified for rural electricfication and power farming with farm and practical experience is desired. Opportunity offered for research work and for participation in experiment station and extension service projects. Teaching work required will be largely in service courses in agricultural engineering. Minimum salary $1800 to $2100 per year on twelve-month's basis with one month vacation. PO-155

AGRICULTURAL ENGINEER wanted as an instructor in mechanical drawing and drawing of farm buildings in one of the leading agricultural engineering departments of the north central states. For a good man with an agricultural engineering degree the salary will be $175 a month for nine months. PO-156

AGRICULTURAL ENGINEER with some knowledge of the design and construction of farm buildings wanted to fill position in engineering department of a farm building manufacturer in the Middle West. Position must be filled by September 1 or 15. Salary to start with will be around $125. PO-157